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ARCHEOLOGY.—*A unique archeological specimen from Australia.*[1]

FRANK M. SETZLER, U. S. National Museum, and FREDERICK D. MCCARTHY, Australian Museum, Sydney.

On October 26 and 27, 1948, within a few days prior to the closing of the Arnhem Land Expedition camp[2] at Oenpelli, we had the good fortune to recover the hafted adz and blade described and illustrated here (Fig. 3). Since these constitute type specimens, it is considered advisable to publish this preliminary description. Oenpelli is located on the western edge of the Arnhem Land Aboriginal Reserve in northern Australia (see map, Fig. 1). The specimens were discovered in a rock shelter, site 2, on Oenpelli Hill (Argaluk) during excavations that constituted a part of the anthropological investigations undertaken by the authors as members of the Arnhem Land Expedition. The excavations of the two rock shelters at the highest point on Oenpelli Hill were under the supervision of the senior author. The type of chipped blade, attached to the wooden handle by means of the hardened ironwood gum, is typical of the many quartzite blades found in most of the 12 rock shelters we excavated on Gallery (Inyalark) and Oenpelli Hills in 1948.

The *elouera* adz-flake had not previously been recorded from Arnhem Land. It has been recorded from Hook Island and Point Cartwright, along the Queensland coast, and occurs occasionally but not as a dominant specialized type in the Pirrian, Mudukian, and Murundian surface sites in far western New South Wales and other parts of the interior of the continent, but is not known in Victoria. It has been recorded on surface sites belonging to the Bondaian culture in the Woakwine Ranges of South Australia (Campbell and Noone, 1943, p. 382, figs. 111–112). One was found in layer IV of the Murundian culture in the Devon Downs rock shelter (Hale and Tindale, 1930). It occurs as a dominant specialized knapped implement in eastern New South Wales on coastal shell-middens, in rock-shelter deposits, and on surface sites from the coast to the tablelands on the western side of the Great Dividing Range (McCarthy, 1943, south coast, pp. 139–140, figs. 17–19, Bathurst, p. 204, fig. 23; McCarthy and Davidson, 1943, Singleton, p. 217, figs. 13–16, 19; McCarthy, Bramell, and Noone, 1946, pp. 27–28, figs. 82–87). The *elouera* adz-flake occurs in both the Bondaian and Eloueran cultures revealed by the Lapstone Creek excavation in the Blue Mountains and is more abundant in the latter and younger culture (McCarthy, 1948).

Up to the time of our discovery it was uncertain as to the use to which these quartzite blades had been put by the Australian aborigines. A great deal of controversy has centered about the way in which the *elouera* was used (the references to which are given by McCarthy, Bramell, and Noone, op. cit.). Some students asserted that it was a chipped-back knife, the thin edge of the chord being used as a knife and the thick, crescentic back shaped for holding in the fingers. Others claimed that its chief function was that of a scraper along its thick margin. McCarthy has always held the opinion that the *elouera* is an adz-flake (McCarthy, Bramell, and Noone, op. cit.,

[1] Received October 3, 1949. Published by permission of the Secretary of the Smithsonian Institution.

[2] Commonwealth of Australia–National Geographic Society–Smithsonian Institution Expedition to Arnhem Land.

p. 29; McCarthy, 1948, p. 31). Noone (1943) recorded six *elouera*-like hafted adz-flakes in the Western Australian Museum's collection. The specimen herein described from Oenpelli is conclusive evidence, as revealed by the X-ray (Fig. 2), that the *elouera* was used as an adz-flake in those parts of Australia in which it occurs as a dominant specialized knapped implement.

The importance of the hafted shell or trimmed stone flake adz as a working tool of the Australian aborigines has long been recognized by Australian archeologists. The stone flake and blade adzes, which are hafted, vary considerably in shape (McCarthy, Bramell, and Noone, 1946, pp. 27–30, figs. 104–109, 324–325, bibliography). Most of them are hafted at the end of a spear-thrower or a rounded wooden, sometimes a bone, handle. The adz-flake is set in a gum cement, the nature of which varies in different localities. However, the working edge of the adz-flake, in the majority of cases, projects transversely, that is, across the end of the handle, but on the specimen from Oenpelli it is mounted laterally (Fig. 3).

The X-ray[3] reveals that the red quartzite adz-flake is of the *elouera* type, with a comparatively straight back or thick lateral margin; it has oblique ends, and the working edge is convex and irregular. This *elouera* adz-flake measures 3.5 cm long, 2.5 cm wide, and 1 cm on the thick margin. The cutting edge projects 1.2 cm from the gum cement. The working edge is not trimmed or retouched but bears use-polish on both facets; this polish is concentrated chiefly on the rounded portion in the middle of the working edge on one side of the flake, but it extends along the other side and is up to 2 mm wide in the middle. The gum cement measures 6 by 5 by 2.5 cm; it is a rounded mass shaped from the thick butt side, which encloses the top of the wooden handle and over half the width of the adz-flake. The X-ray reveals that the thick back of the adz-flake is not set against the wood but is separated by gum almost 1 cm wide from the handle, and that the top of the handle

[3] Kindly made by Drs. J. L. and K. E. Shellshear, of Sydney.

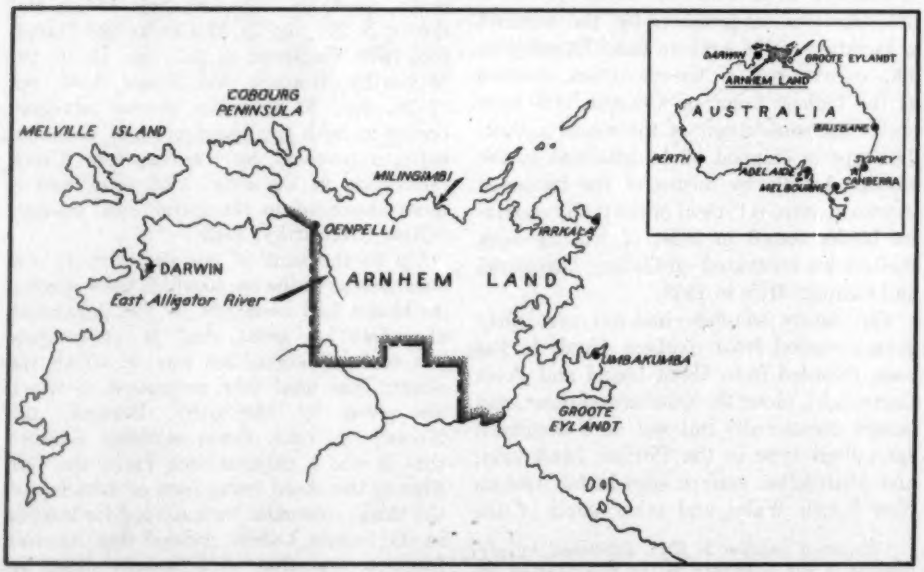

FIG. 1.—Map showing location of Oenpelli on the western edge of Arnhem Land, Northern Australia.

is barely covered with gum. The handle is a roughly shaped strip of ironwood (*Erythrophloeum chlorostachyus* or *E. laboucherii*); it is flattened on both sides and tapers to a point at the grip end. It is 35 cm long, 3 cm wide, and just over 1 cm thick in some parts and is almost black on one side and light brown on the other. There is a shallow

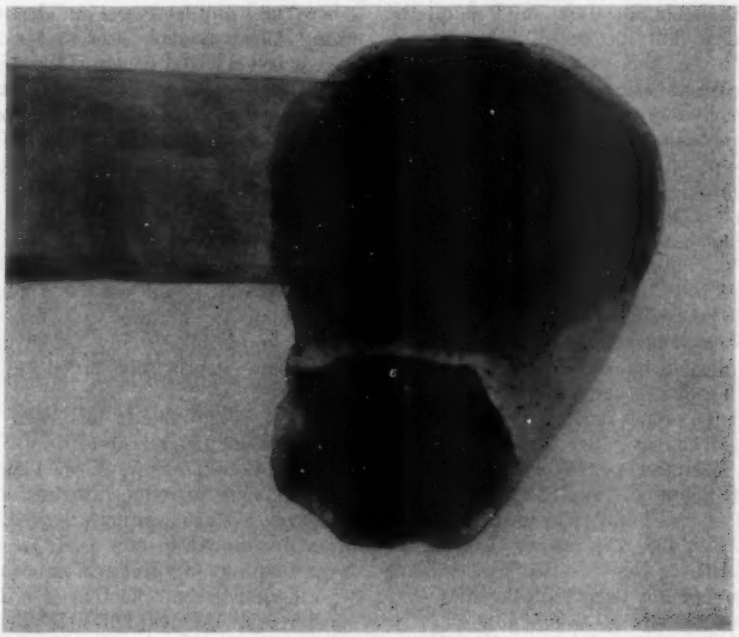

FIG. 2.—X-ray photograph of hafted adz showing the chipped quartzite adz-flake similar to those illustrated in Fig. 3.

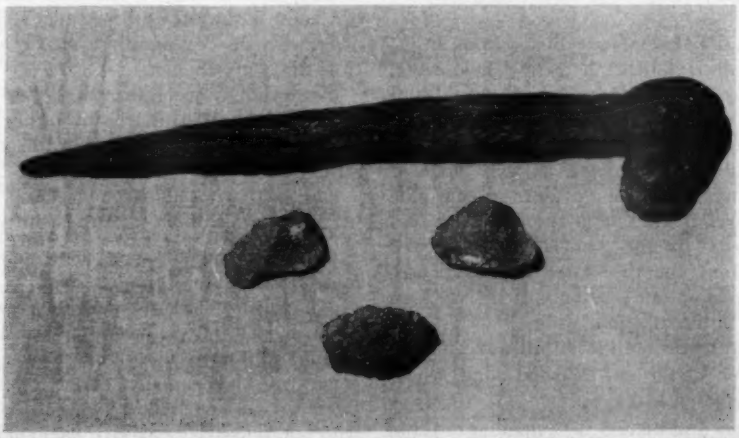

FIG. 3.—The hafted adz and *elouera* flake; also three types of chipped quartzite blades excavated in cave no. 2, on Oenpelli Hill (Argaluk). Length of adz 13¾ inches (35 cm); width 1¼ inches (3 cm); thickness, 3/8 inch (1 cm).

depression 6 cm long in the middle of the inner edge, which forms a convenient grip. All the ridges on the dark side of this handle are polished as though from the holding of the tool during use, particularly from the middle to the pointed end, and along the concave area, but this polish is barely perceptible on the other side. The gum cement is obtained by heating the roots of the ironwood tree.

The *elouera* proved to be a dominant specialized type of knapped implement in the Oenpelli rock shelters that we excavated, and many of the *elouera* recovered bear a pronounced use-polished working edge or sheen on the chord. Most of them are made of red quartzite, and they are identical in form and dimensions with the eastern New South Wales *elouera* made out of a variety of cherts, jasper, quartzite, chalcedony, silicified wood, and other materials. The use-polished edge occurs on *elouera* in the latter locality (McCarthy, 1943, south coast, pp. 132, 145, Bathurst, p. 207; 1948, pp. 7, 15) but not so commonly as at Oenpelli and on the large *worimi* hand cleavers (McCarthy, 1947, pp. 420, 423, 426, figs. 8, 11) from the north coast of New South Wales. Thus another important aspect of the discovery of this hafted adz at Oenpelli is that its adz-flake, an *elouera*, has a use-polished edge, a kind of working edge to which attention has only previously been drawn by the above author.

A second red quartzite blade from site 2 on Oenpelli Hill bears a use-polished edge. This blade is 4 cm long, 3.5 cm wide, and 3.5 mm thick, although at one end, broken transversely, it is only 2 mm thick. This thin blade had also been hafted, since it bears a layer of gum cement on one side which is 6 mm thick, and the area that had been covered by the gum is clean and well defined from the discolored area exposed. The sheen is on one side only of the working edge and is up to 2 mm wide.

The use made of the hafted adz and the explanation of the use-polished edge, which appears also as a diagnostic trait on many other flakes and blades at Oenpelli, are problems that must remain within the realm of theory. Local natives, even the old men, were unable to give any specific uses, and most of them suggested that it was a woodworking tool. A suggestion advanced by one of the native workmen on the excavation was that it could have been used for enlarging the hole made in a tree to cut out a bees' nest and to scrape out the comb and honey. Other possible uses that would produce a use-polished edge are the dressing of skins, cleaning off outer bark, and smoothing off the surfaces of wooden shields, clubs, spear-throwers, and sacred objects. That the usage was of some variety is indicated by the occurrence of this type of working edge on implements ranging from thin flakes to hand cleavers, and on hafted adzes.

The hafted adz from Oenpelli weighs only 5 ounces and would not be a burden for these nomadic hunters and fishermen to carry about. Like many other aboriginal implements, it probably served a number of purposes.

No other hafted adz has been recorded from Arnhem Land, where the use of stone implements began to wane when the Makassan trepangers introduced metal tomahawks and knives some centuries ago, to be followed by the white man early in the nineteenth century. Sir Baldwin Spencer (1914), who made a large collection of ethnological specimens at Oenpelli and neighboring areas in 1912; Basedow (1907), who described the material culture of the west coast; Tindale (1922), who described the material culture of Groote Eylandt; and Warner (1937), who dealt with the Milingimbi area, do not mention this implement.

The original specimens described are deposited in the Australian Museum in Sydney. Casts will be sent to the Smithsonian Institution.

Our field work in Arnhem Land resulted in the establishment of three cultures:

PIRRIAN: *Pirri* uniface points, and scrapers, found on a surface site at Yirrkala.

MILINGIMBIAN: Edge-ground biface axes (some of which are highly polished from the blade to the middle of the ax), *Riambi* oyster picks, hammerstones and hammer-anvil stones, pestles and mortars, red and yellow pigments, associated with an unconventionalized flake industry in which there are *no* points. From the large shell midden known as the Macassar Well site on Milingimbi Island.

OENPELLIAN: Uniface (*Pirri*) points and biface points, *elouera* adz-flake as the dominant flake type, a variety of scrapers (many of microlithic size but none of geometrical type present), *Leilira* quartzite blades, flake-fabricated hammerstones, red and yellow pigments, bone *muduk* points, pestle and mortars; *elouera*, flake and blades with use-polished working edge. Associated with top deposit and bundle burials, modern iron nails and implements, twined and netted bag fragments, wooden weapons, trade beads.

This note serves only as a general description of an important archeological discovery in Arnhem Land. The authors are preparing detailed reports of their anthropological investigations during the eight months of field work in this northern section of Australia. This international expedition, led by the Australian representative C. P. Mountford, was made possible through the joint sponsorship of the Commonwealth of Australia, the National Geographic Society, and the Smithsonian Institution.

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PALEONTOLOGY.—*North American Jurassic Foraminifera, II: Characteristic western interior Callovian species.*[1] ALFRED R. LOEBLICH, JR., U. S. National Museum, and HELEN TAPPAN, U. S. Geological Survey.

Callovian (basal Upper Jurassic) beds contain rich and well-preserved foraminiferal assemblages in many parts of the western interior of the United States and Canada. In the eastern area of exposures around the Black Hills of South Dakota and Wyoming the medial part of the Lower Callovian consists in large part of sandy siltstone that contains abundant Ostracoda and sparsely developed foraminiferal assemblages dominated by simple lagenids and arenaceous Foraminifera. Toward the west in Wyoming and Montana the Callovian strata become more calcareous, and Foraminifera dominate the microfossil assemblages. The foraminiferal assemblages are also more diversified to the west and are characterized by a great variety of lagenids and lituolids.

The writers have in preparation a monographic treatment of the western interior Jurassic Foraminifera but are here recording a few of the more characteristic species, so that they may be of use in stratigraphic work now in progress in the area. The field work was undertaken as a project of the U. S. Geological Survey, and the writers are indebted to Dr. Ralph W. Imlay for his valuable assistance in the field and to Dr.

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John B. Reeside, Jr., for his interest and aid in making possible the field study and collection of material.

DESCRIPTION OF LOCALITIES

Locality 1.—Ellis group. At the southwest corner of Red Dome, east of Bridger, in the Pryor Mountains, sec. 19, T.7S., R.24E., Carbon County, Montana. Collected September 13, 1948, by Ralph W. Imlay and Alfred R. Loeblich, Jr. A complete section of the Ellis Group (Piper, Rierdon and Swift formations) is well exposed at this locality.

Locality 2.—Ellis group. One mile southwest of Piper on the northwest corner of the escarpment due east of Bacon Ranch, sec. 17, T.14N., R.20E., Fergus County, Montana. Collected September 14, 1948, by Ralph W. Imlay and Alfred R. Loeblich, Jr. This locality includes the type section of the Piper formation, an excellent exposure of the Rierdon formation, and the basal portion of the Swift formation.

Locality 3.—Sundance formation. On the west side of Stockade Beaver Creek, 5 miles northeast of Newcastle, sec. 18, T.45N., R.60W., Weston County, Wyoming. Collected September 21, 1948, by Ralph W. Imlay and Alfred R. Loeblich, Jr. This locality is the type section of the Stockade Beaver shale member, and in addition, the Hulett sandstone member, the Lak member, and the basal part of the Redwater shale member of the Sundance are well shown.

Locality 4.—Sundance formation. Along the east side of Red Gulch, about 2½ miles south of little Big Horn River in sec. 22, T.58N., R.89W., Sheridan County, Wyoming. Collected by R. W. Imlay and A. R. Loeblich, Jr., September 23, 1948. This locality affords excellent exposures of the Stockade Beaver shale member, Hulett sandstone member, and Redwater shale member of the Sundance.

Locality 5.—In the gorge of the Shoshone River, 1¼ miles west of Cody, Park County, Wyoming. Collected September 19, 1948, by Ralph W. Imlay and Alfred R. Loeblich, Jr. This locality exposes in detail the entire marine Jurassic sequence found in this area.

Locality 6.—Sundance formation. On the east side of Elk Mountain, about 15 miles southeast of Newcastle, Wyoming, in the S½ sec. 19, T.4S., R.1E., South Dakota. Collected September 22, 1948, by Ralph W. Imlay and A. R. Loeblich, Jr. This locality is an excellent one for the lower portion of the Stockade Beaver shale member.

Locality 7.—Sundance formation. In the J. H. Kline Well no. 1, 3½ miles southeast of Carpio, Ward County, North Dakota.

DESCRIPTION OF FORAMINIFERA

Family AMMODISCIDAE

Subfamily AMMODISCINAE

Genus **Ammodiscus** Reuss, 1861

Ammodiscus cheradospirus Loeblich and Tappan, n. sp.
Pl. 1, figs. 1–2b

Test free, medium-sized, discoidal, somewhat irregularly planispirally coiled, periphery rounded with margins irregular; proloculum, in holotype 0.08 mm in diameter, circular, tubular second chamber increasing gradually in size, only occasionally overlapping the preceding coil; spiral suture distinct, depressed; wall very finely arenaceous, with much cement, insoluble in acid; aperture formed by the open end of the tubular chamber.

Maximum diameter of holotype 0.68 mm, diameter of figured paratype 0.44 mm, maximum thickness 0.10 mm. Other specimens vary in diameter from 0.55 mm to 1.53 mm.

Types and occurrence.—Holotype (U.S.N.M. no. 106014) and figured paratype (U.S.N.M. no. 106015) and unfigured paratypes (U.S.N.M. no. 106016) from the Rierdon formation, 33 feet above the base, at locality 1. Specimens are common in this level of the Rierdon formation at this locality.

Remarks.—This species differs from *Ammodiscus gaultinus* Berthelin from the Lower Cretaceous of France in being more regularly planispiral and in being somewhat larger in size.

Family LITUOLIDAE

Subfamily HAPLOPHRAGMIINAE

Genus **Frankeina** Cushman and Alexander, 1929

Frankeina commutata Loeblich and Tappan, n. sp.
Pl. 1, figs. 3a–4

Frankeina sp.? Wickenden, Trans. Royal Soc. Canada, ser. 3, sec. IV, **27**: 158, pl. 1, fig. 2. 1933.

Test free, medium-sized, elongate, compressed and planispiral in the early part, later uniserial and triangular in section, periphery rounded; planispiral chambers strongly compressed, comprising a relatively large portion of the test, about one and two-thirds volutions in the coil;

later portion uniserial, chambers increasing slowly in diameter, in the holotype the final chamber being less in diameter than the early coil, sides moderately excavated; sutures generally indistinct, in the coiled part straight or with a very slight backward curve, very slightly depressed in the uniserial portion, but generally indistinct except at peripheral angles; wall medium to coarsely arenaceous, surface roughly finished; aperture rounded on a slight neck.

Length of holotype 1.77 mm, greatest diameter of coiled part 0.75 mm, greatest width of uniserial portion 0.68 mm, width from center of side through opposite angle 0.39 mm; greatest diameter of coil in figured paratype 0.55 mm. Other specimens vary from 0.65 mm to 1.92 mm in length and in diameter of early coiled part from 0.39 mm to 0.75 mm.

Types and occurrence.—Holotype (U.S.N.M. no. 106017) and unfigured paratypes (U.S.N.M. no. 106018) from 99 feet above the base of the Rierdon formation, unfigured paratypes (U.S.N.M. no. 106019) from 104 feet above base of Rierdon formation, unfigured paratypes (U.S.N.M. no. 106020) from 134 feet above the base of the Rierdon formation, all from locality 5; figured paratype (U.S.N.M. no. 106021) and unfigured paratypes (U.S.N.M. no. 106022) from 81 feet above the base of the Rierdon formation, unfigured paratypes (U.S.N.M. no. 106023) from 33 feet above the base of the Rierdon formation, all from locality 1; unfigured paratypes (U.S.N.M. no. 106024) from the Stockade Beaver shale member of the Sundance, 47 to 52 feet above the base, at locality 4. Wickenden recorded the species from about the middle of the Jurassic sequence in the subsurface of Saskatchewan. *Frankeina* in the western interior Jurassic is common in the calcareous shales of the Rierdon and equivalent strata, and with the exception of an occurrence of a related species (U.S.N.M. no. 106025) in the lower part of the Swift formation (*Quenstedtoceras collieri* zone) in the Little Rocky Mountains, it appears to be restricted to this interval.

Remarks.—This species is closer to *Frankeina incerta* Alexander and Smith, from the Lower Cretaceous of Texas, than to any other described species, in size and in having a comparatively large coil. The Jurassic form differs in having a more pronounced coil, of diameter equal to the breadth of the later triangular portion, and in lacking the *Flabellammina* stage characteristic of *F. incerta*, before the triangular character appears. The chambers do not enlarge so rapidly, the sides are more excavated and the sutures are more distinct in *F. commutata*, n. sp.

Family LAGENIDAE

Subfamily NODOSARIINAE

Genus **Lenticulina** Lamarck, 1804

Lenticulina dilecta Loeblich and Tappan, n. sp.
Pl. 1, figs. 5a–8

Lenticulina helios (Terquem), Sandidge, Amer. Midland Nat. **14:** 178, pl. 1, figs. 1–2. 1933.
Lenticulina sarthacensis (Schwager), Wickenden, Trans. Royal Soc. Canada, ser. 3, sec. IV, **27:** p. 160, pl. 1, figs. 9 and 11 (not fig. 10). 1933.

Test free, lenticular, of medium size, close-coiled, but not completely involute, earlier coils visible in the umbilical region, generally planispiral, but occasional specimens distinctly trochoid, periphery subacute, with a keel; chambers numerous, increasing in size as added, 9 to 11 in the final whorl, depressed centrally; sutures slightly curved, distinct, raised and limbate, occasionally with minute lateral projections on the surface; wall calcareous, hyaline, surface ornamented by the peripheral keel, the elevated sutures which are thickest and highest toward the umbonal area, and the depressed umbilicus, with an encircling ridge formed by the coalescing ends of the sutures; aperture at the peripheral angle, rounded, occasionally faintly crenulated at the margins, showing a tendency toward the radiate character of younger species of the genus.

Greatest diameter of holotype 0.70 mm, least diameter 0.49 mm, greatest thickness 0.26 mm. Other specimens are from 0.34 mm to 0.81 mm in greatest diameter.

Types and occurrence.—Holotype (U.S.N.M. no. 106026), figured paratypes (U.S.N.M. no. 106027 a–c) and unfigured paratypes (U.S.N.M. no. 106028) from 104 feet above the base of the Rierdon formation, unfigured paratypes (U.S.N.M. no. 106029) from 99 feet above the base of the Rierdon formation, all from locality 5; unfigured paratypes (U.S.N.M. no. 106030) from the Rierdon formation, 33 feet above the base, at locality 1; unfigured paratypes (U.S.N.M. nos. 106031 to 106034) from cuttings in the Sundance formation at depths of 4,185–4,190, 4,195–4,200, 4,205–4,210, and 4,245–4,250 at locality 7.

Remarks.—This species differs from *Cristellaria helios* Terquem in being biumbilicate rather than biumbonate, in having fewer chambers, in

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Pl. 1, figs. 3a–4

Frankeina sp.? Wickenden, Trans. Royal Soc. Canada, ser. 3, sec. IV, **27**: 158, pl. 1, fig. 2. 1933.

Test free, medium-sized, elongate, compressed and planispiral in the early part, later uniserial and triangular in section, periphery rounded; planispiral chambers strongly compressed, comprising a relatively large portion of the test, about one and two-thirds volutions in the coil;

later portion uniserial, chambers increasing slowly in diameter, in the holotype the final chamber being less in diameter than the early coil, sides moderately excavated; sutures generally indistinct, in the coiled part straight or with a very slight backward curve, very slightly depressed in the uniserial portion, but generally indistinct except at peripheral angles; wall medium to coarsely arenaceous, surface roughly finished; aperture rounded on a slight neck.

Length of holotype 1.77 mm, greatest diameter of coiled part 0.75 mm, greatest width of uniserial portion 0.68 mm, width from center of side through opposite angle 0.39 mm; greatest diameter of coil in figured paratype 0.55 mm. Other specimens vary from 0.65 mm to 1.92 mm in length and in diameter of early coiled part from 0.39 mm to 0.75 mm.

Types and occurrence.—Holotype (U.S.N.M. no. 106017) and unfigured paratypes (U.S.N.M. no. 106018) from 99 feet above the base of the Rierdon formation, unfigured paratypes (U.S.N.M. no. 106019) from 104 feet above base of Rierdon formation, unfigured paratypes (U.S.N.M. no. 106020) from 134 feet above the base of the Rierdon formation, all from locality 5; figured paratype (U.S.N.M. no. 106021) and unfigured paratypes (U.S.N.M. no. 106022) from 81 feet above the base of the Rierdon formation, unfigured paratypes (U.S.N.M. no. 106023) from 33 feet above the base of the Rierdon formation, all from locality 1; unfigured paratypes (U.S.N.M. no. 106024) from the Stockade Beaver shale member of the Sundance, 47 to 52 feet above the base, at locality 4. Wickenden recorded the species from about the middle of the Jurassic sequence in the subsurface of Saskatchewan. *Frankeina* in the western interior Jurassic is common in the calcareous shales of the Rierdon and equivalent strata, and with the exception of an occurrence of a related species (U.S.N.M. no. 106025) in the lower part of the Swift formation (*Quenstedtoceras collieri* zone) in the Little Rocky Mountains, it appears to be restricted to this interval.

Remarks.—This species is closer to *Frankeina incerta* Alexander and Smith, from the Lower Cretaceous of Texas, than to any other described species, in size and in having a comparatively large coil. The Jurassic form differs in having a more pronounced coil, of diameter equal to the breadth of the later triangular portion, and in lacking the *Flabellammina* stage characteristic of *F. incerta*, before the triangular character appears. The chambers do not enlarge so rapidly, the sides are more excavated and the sutures are more distinct in *F. commutata*, n. sp.

Family LAGENIDAE

Subfamily NODOSARIINAE

Genus **Lenticulina** Lamarck, 1804

Lenticulina dilecta Loeblich and Tappan, n. sp.
Pl. 1, figs. 5a–8

Lenticulina helios (Terquem), Sandidge, Amer. Midland Nat. **14:** 178, pl. 1, figs. 1–2. 1933.
Lenticulina sarthacensis (Schwager), Wickenden, Trans. Royal Soc. Canada, ser. 3, sec. IV, **27:** p. 160, pl. 1, figs. 9 and 11 (not fig. 10). 1933.

Test free, lenticular, of medium size, close-coiled, but not completely involute, earlier coils visible in the umbilical region, generally planispiral, but occasional specimens distinctly trochoid, periphery subacute, with a keel; chambers numerous, increasing in size as added, 9 to 11 in the final whorl, depressed centrally; sutures slightly curved, distinct, raised and limbate, occasionally with minute lateral projections on the surface; wall calcareous, hyaline, surface ornamented by the peripheral keel, the elevated sutures which are thickest and highest toward the umbonal area, and the depressed umbilicus, with an encircling ridge formed by the coalescing ends of the sutures; aperture at the peripheral angle, rounded, occasionally faintly crenulated at the margins, showing a tendency toward the radiate character of younger species of the genus.

Greatest diameter of holotype 0.70 mm, least diameter 0.49 mm, greatest thickness 0.26 mm. Other specimens are from 0.34 mm to 0.81 mm in greatest diameter.

Types and occurrence.—Holotype (U.S.N.M. no. 106026), figured paratypes (U.S.N.M. no. 106027 a–c) and unfigured paratypes (U.S.N.M. no. 106028) from 104 feet above the base of the Rierdon formation, unfigured paratypes (U.S.N.M. no. 106029) from 99 feet above the base of the Rierdon formation, all from locality 5; unfigured paratypes (U.S.N.M. no. 106030) from the Rierdon formation, 33 feet above the base, at locality 1; unfigured paratypes (U.S.N.M. nos. 106031 to 106034) from cuttings in the Sundance formation at depths of 4,185–4,190, 4,195–4,200, 4,205–4,210, and 4,245–4,250 at locality 7.

Remarks.—This species differs from *Cristellaria helios* Terquem in being biumbilicate rather than biumbonate, in having fewer chambers, in

being about one-half as large, and in having comparatively greater thickness.

Genus **Astacolus** Montfort, 1808

Astacolus ectypus Loeblich and Tappan, n. sp.
Pl. 1, figs. 14–18b

Lenticulina sculpta (Terquem and Berthelin), Sandidge, Amer. Midland Nat. **14:** 179, pl. 1, fig. 10. 1933.

Lenticulina sarthacensis (Schwager), Wickenden, Trans. Royal Soc. Canada, ser. 3, sec. IV, **27:** 160, pl. 1, figs. 10a–b (not figs. 9 and 11). 1933.

Test free, large, auriculate to elongate in outline, early portion close-coiled, later uncoiling, with chambers extending back nearly or completely to the coil on the ventral margin, microspheric individuals showing a more enrolled early portion and broader test, while megalospheric forms are narrower and more evolute and elongate, periphery acute, keeled, ventral face truncate; chambers numerous, as many as 16 in well-developed microspheric specimens, as many as 11 in megalospheric specimens, sharply inflated just anterior to the sutures, well preserved specimens showing a distinct ridge which roughly parallels the sutures but sometimes is more strongly curved toward the aperture in the central portion of the test; sutures distinct, deeply depressed, curved; wall calcareous, hyaline, surface smooth, with no ornamentation other than the peripheral keel and the previously mentioned ridge paralleling the sutures; aperture at the peripheral angle, radiate.

Length of megalospheric holotype 0.70 mm, greatest breadth of coil 0.34 mm, greatest breadth above coil 0.31 mm, greatest thickness 0.21 mm. Length of microspheric paratype 0.78 mm, greatest breadth 0.42 mm, greatest thickness 0.21 mm. Other specimens vary in length from 0.36 to 0.86 mm.

Types and occurrence.—Holotype (U.S.N.M. no. 106035), figured paratypes (U.S.N.M. no. 106036a–c), and unfigured paratypes (U.S.N.M. no. 106037) from 47 to 52 feet above the base of the Stockade Beaver shale member of the Sundance formation at locality 4; unfigured paratypes (U.S.N.M. no. 106038) from 99 feet above the base, figured paratype (U.S.N.M. no. 106039) and unfigured paratypes (U.S.N.M. no. 106040) from 104 feet above the base, unfigured paratypes (U.S.N.M. no. 106041) from 134 feet above the base, all from the Rierdon formation at locality 5; unfigured paratypes (U.S.N.M. no. 106042) from 55 feet above the base and unfigured paratypes (U.S.N.M. no. 106043) from 81 feet above the base, both from the Rierdon formation at locality 1; unfigured paratypes (U.S.N.M. no. 106044) from the Sundance formation, in cuttings at 4,180–4,185 feet, at locality 7.

Remarks.—This species is similar to *Cristellaria sarthacensis* Schwager but differs in lacking the raised sutures and in being more evolute. In *A. ectypus*, n. sp., the sutures are depressed, but the chambers are inflated just anterior to the sutures, forming a distinct ridge. *Astacolus ectypus*, n. sp., differs from *Cristellaria sculpta* Terquem and Berthelin in being nearly twice as large and in having a much less well defined keel.

Wickenden (1933, p. 160) included under *Lenticulina sarthacensis* (Schwager) a specimen of this species, as well as specimens similar to those here described as *Lenticulina dilecta*, n. sp. *Astacolus ectypus*, n. sp., differs from *L. dilecta*, n. sp., in having a smaller coiled portion, with the later chambers uncoiling, in having strongly inflated chambers and depressed sutures rather than elevated and spinose sutures, and in lacking the open umbilicus.

Astacolus petalus Loeblich and Tappan, n. sp.
Pl. 1, figs. 19–21b

Test free, of medium size, auriculate in outline, much compressed, sides flat and parallel, early portion coiled, later uncoiling, later chambers extending back toward the proloculus on the ventral margin, periphery subtruncate; chambers numerous, as many as 10 or 11 in larger specimens, increasing very slightly in height as added, but increasing rapidly in breadth, so that later chambers are four to five times as broad as high; sutures gently curved, very slightly depressed, varying from quite distinct and clear in some specimens to somewhat obscure in others, so that they can be well distinguished only when the specimen is dampened; wall calcareous, hyaline, surface smooth; aperture at the peripheral angle, radiate.

Length of holotype 0.88 mm, greatest breadth 0.44 mm, greatest thickness 0.10 mm. Other specimens are from 0.39 mm to 0.91 mm in length.

Types and occurrence.—Holotype (U.S.N.M. no. 106045), figured paratypes (U.S.N.M. 106046a–b), and unfigured paratypes (U.S.N.M. no. 106047) from 47 to 52 feet above the base of the Stockade Beaver shale member of the Sundance formation at locality 4; unfigured paratypes (U.S.

N.M. no. 106048) from 55 feet above the base of the Rierdon formation and (U.S.N.M. no. 106049) from 81 feet above the base of the Rierdon formation, both from locality 1; unfigured paratypes (U.S.N.M. no. 106050) from 99 feet above the base of the Rierdon formation at locality 5.

Remarks.—*Astacolus petalus*, n. sp., is similar to *Cristellaria acuminata* Terquem but is nearly one-third smaller and has a less enrolled early portion. It differs from *Cristellaria anceps* Terquem in being nearly twice as large and in having less embracing chambers.

Genus **Marginulinopsis** Silvestri, 1904

Marginulinopsis phragmites Loeblich and Tappan, n. sp.

Pl. 1, figs. 22–23b; text fig. 1.

Marginulina cf. *lacunata* (Terquem), Sandidge, Amer. Midland Nat. **14:** 180, pl. 1, figs. 6–8. 1933.

Marginulina cf. *lacunata* (Terquem and Berthelin), Wickenden, Trans. Royal Soc. Canada, ser. 3, sec. IV, **27:** 162, pl. 1, fig. 13. 1933.

Marginulina cf. *sparsa* (Terquem and Berthelin), Wickenden, Trans. Royal Soc. Canada, ser. 3, sec. IV, **27:** p. 161, pl. 1, fig. 14. 1933.

Test free, elongate, robust, early portion coiled, later portion rectilinear, rounded to slightly flattened in section; chambers numerous, increasing in size as added, as many as 10; sutures straight, radiate at first, later horizontal, obscured by the surface ornamentation; wall calcareous, hyaline, surface ornamented by 10 to 12 very strongly elevated costae, which are continuous across the sutures; aperture radiate, terminal, produced on a short neck.

Length of holotype 0.96 mm, greatest diameter of coil 0.26 mm, greatest breadth of uniserial portion 0.36 mm, greatest thickness 0.29 mm. Other specimens vary from 0.23 to 0.96 mm in length.

Types and occurrence.—Holotype (U.S.N.M. no. 106051), figured paratype (U.S.N.M. no. 106052), and unfigured paratypes (U.S.N.M. no. 106053) from the Stockade Beaver shale member of the Sundance formation, 47 to 52 feet above the base at locality 4; unfigured paratypes (U.S.N.M. no. 106054) from 33 feet above the base, figured paratype (U.S.N.M. no. 106055) and unfigured paratypes (U.S.N.M. no. 106056) from 55 feet above the base, unfigured paratypes (U.S.N.M. no. 106057) from 81 feet above the base, all from the Rierdon formation at locality 1; unfigured paratypes from 99 feet (U.S.N.M. 106058), 104 feet (U.S.N.M. no. 106059), and 134 feet (U.S.N.M. no. 106060) above the base of the Rierdon formation at locality 5; unfigured paratypes from 4,185–4,190 feet, (U.S.N.M. no. 106061), 4,195–4,200 feet (U.S.N.M. no. 106062), 4,200–4,205 feet (U.S.N.M. no. 106063), 4,205–4,210 feet (U.S.N.M. no. 106064), and 4,245–4,250 feet (U.S.N.M. no. 106065), all from cuttings in the Sundance formation at locality 7.

FIG. 1.—*Marginulinopsis phragmites* Loeblich and Tappan, n. sp.: Paratype (U.S.N.M. no. 106055), section showing globular proloculus and cristellarian coil, followed by uniserial chambers. × 72.

Remarks.—*Marginulinopsis phragmites*, n. sp., is similar to *Cristellaria* (*Marginulina*) *jonesi* Reuss but is about one-half as large and has fewer ribs, which in most specimens traverse all the chambers. In *Cristellaria* (*Marginulina*) *jonesi* Reuss the ribs do not traverse the final chamber. *Marginulinopsis phragmites*, n. sp., differs from *Cristellaria lacunata* Terquem and Berthelin in possessing more ribs and in being much smaller. It differs from *Cristellaria sparsa* Terquem and Berthelin in possessing fewer ribs and in being of much larger size.

Genus **Vaginulinopsis** Silvestri, 1904

Vaginulinopsis eritheles Loeblich and Tappan, n. sp.

Pl. 1, figs. 9a–13

Marginulina sp.? Wickenden, Trans. Royal Soc. Canada, ser. 3, sec. IV, **27:** p. 163, pl. 1, figs. 12a–b. 1933.

Test free, large, elongate, early portion close-coiled and cristellarian in character, strongly inflated centrally, with an umbonal boss, periphery with a distinct keel, later portion uncoiling with periphery broadly rounded, microspheric forms broader and larger, with a better-developed coil than in the megalospheric specimens; chambers numerous, low and broad, as many as 12 in the final whorl of the microspheric form and 7 to 9 in the megalospheric form, followed by 2 to 4

uncoiled chambers which are inflated near the ventral margin and flattened toward the dorsal margin, so that the uniserial chambers are ovate to subtriangular in section; sutures slightly curved and flush with the surface in the cristellarian portion, distinct to obscure, depending on the preservation of the specimen in question, depressed, nearly straight and quite distinct in the uncoiled portion; wall calcareous, hyaline, surface smooth; aperture radiate, at the peripheral angle which is somewhat produced.

Length of megalospheric holotype 0.96 mm, greatest breadth of coil 0.47 mm, greatest breadth of uniserial portion 0.29 mm, greatest thickness 0.23 mm. Length of microspheric paratype 1.40 mm, greatest breadth of coiled portion 0.62 mm, greatest breadth of uniserial portion 0.49 mm, greatest thickness 0.36 mm. Other specimens are from 0.44 mm to 1.40 mm in length.

Types and occurrence.—Holotype (U.S.N.M. no. 106066), figured paratypes (U.S.N.M. nos. 106067a–d), and unfigured paratypes (U.S.N.M. no. 106068) from the Stockade Beaver shale member of the Sundance formation, 47 to 52 feet above the base, at locality 4; unfigured paratypes (U.S.N.M. no. 106069) from 99 feet above the base and unfigured paratypes (U.S.N.M. no. 106070) from 104 feet above the base of the Rierdon formation, both from locality 5; unfigured paratypes (U.S.N.M. no. 106071) from 33 feet above the base, and unfigured paratypes (U.S.N.M. no. 106072) from 81 feet above the base, both from the Rierdon formation at locality 1; unfigured paratype (U.S.N.M. no. 106073) from the Sundance formation, in cuttings at 4,205–4,210 feet at locality 7.

Remarks.—This species resembles *Cristellaria centralis* Terquem from the Upper Bajocian of France in size and general appearance but is less compressed and has more horizontal and less depressed sutures. *Vaginulinopsis eritheles*, n. sp. differs from *Cristellaria vetusta* d'Orbigny in lacking the limbate sutures in the early part, in possessing depressed sutures in the later part, and in being of slightly larger size.

Genus **Dentalina** d'Orbigny, 1826

Dentalina gracilistriata Loeblich and Tappan, n. sp.
Pl. 1, figs. 24a-b

Test free, elongate, arcuate, of medium size; chambers uniserially arranged, slightly inflated centrally, increasing gradually in diameter as added, and more rapidly in length so that the final chambers are of somewhat greater length than breadth; sutures distinct, straight, slightly constricted; wall calcareous, hyaline, surface ornamented with numerous very fine wavering ribs, about 18 to 20 in number; aperture terminal, rounded, with margins showing indentations suggestive of a radiate character.

Length of holotype 0.81 mm, greatest breadth 0.16 mm.

Type and occurrence.—Holotype (U.S.N.M. no. 106074) from 47 to 52 feet above the base of the Stockade Beaver shale member of the Sundance formation at locality 4.

Remarks.—This species is somewhat similar to *Dentalina cylindrica* Schwager but differs in having lower chambers and in being ornamented by fine ribs. It differs from *D. fraasi* Schwager in having a less acuminate base and in possessing the fine ribs.

Dentalina ochyra Loeblich and Tappan, n. sp.
Pl. 1, figs. 25a–b

Test free, elongate, robust, slightly arcuate; chambers uniserially arranged, as many as 8 in well-developed specimens, increasing gradually in size as added from the rounded base, final chamber occasionally of somewhat less diameter than the preceding chamber; sutures straight, at right angles to the axis, occasionally slightly constricted, generally obscure; wall calcareous, hyaline, surface ornamented with about 16 to 18 low and narrow but continuous ribs of considerable regularity, increasing in number by intercalation as the test diameter increases; aperture terminal, radiate, on a short neck.

Length of holotype 1.07 mm, maximum diameter 0.26 mm. Other specimens varying in length from 0.44 mm to 1.09 mm.

Types and occurrence.—Holotype (U.S.N.M. no. 106075) and unfigured paratypes (U.S.N.M. no. 106076) from the Stockade Beaver shale member of the Sundance formation, 47 to 52 feet above the base, at locality 4; unfigured paratypes (U.S.N.M. no. 106077) from 139 feet above the base and unfigured paratypes (U.S.N.M. no. 106078) from 81 feet above the base, both from the Rierdon formation at locality 1; unfigured paratypes (U.S.N.M. no. 106079) from the Rierdon formation, 15 feet above the base, at locality 2; unfigured paratypes (U.S.N.M. no. 106080) from the Rierdon formation, 134 feet above the base, at locality 5.

Remarks.—This species somewhat resembles *Dentalina pectinata* Terquem, from the Upper

Bajocian of France, in general appearance and in having numerous ribs, but it is about twice as large and the test is almost cylindrical instead of constricted at the sutures. It is similar to *Dentalina confluens* Reuss but has less oblique sutures and is approximately one half as large.

Dentalina polyholca Loeblich and Tappan, n. sp.
Pl. 1, figs. 26–28

Test free, elongate, rectilinear, tapered or subcylindrical; chambers numerous, as many as 10, increasing gradually in size from the rounded proloculus in the microspheric specimens, but increasing very little in height or diameter in the megalospheric forms, final chamber sometimes of reduced size; sutures fairly distinct, straight, slightly constricted; wall calcareous, hyaline, surface ornamented with numerous fine ribs, about 20 to 25 in number, which are slightly undulating and occasionally bifurcate; aperture terminal, radiate, on a slight neck.

Length of microspheric holotype 1.20 mm, greatest diameter 0.21 mm; length of megalospheric paratype 0.70 mm, greatest diameter 0.18 mm. Other specimens are from 0.49 mm to 1.20 mm in length.

Types and occurrence.—Holotype (U.S.N.M. no. 106081) and unfigured paratypes (U.S.N.M. no. 106082) from the Rierdon formation, 15 feet above the base, at locality 2; figured paratypes (U.S.N.M. no. 106083) and unfigured paratypes (U.S.N.M. no. 106084) from the Stockade Beaver shale member of the Sundance formation, 47 to 52 feet above the base, at locality 4; unfigured paratype (U.S.N.M. no. 106085) from the Rierdon formation, 134 feet above the base, at locality 5; unfigured paratype (U.S.N.M. no. 106086) from the Rierdon formation, 81 feet above the base, at locality 1.

Remarks.—This species is similar to *D. angusticosta* Cushman, but has a more robust test and is about one-half as large. It is somewhat similar to *Nodosaria amphioxys* Reuss but has many more ribs, less constricted chambers, and an excentric aperture.

Genus **Nodosaria** Lamarck, 1812

Nodosaria orthostoecha Loeblich and Tappan, n. sp.
Pl. 1, figs. 33a–b

Nodosaria cf. *corallina* Gümbel, Wickenden, Trans. Royal Soc. Canada, ser. 3, sec. IV, **27**: 165, pl. 2, fig. 11. 1933.

Test free, elongate, rectilinear, of medium size; chambers numerous, as many as 7, varying from subglobular to somewhat broader than high, increasing very little in diameter as added, in many specimens the proloculus is of greater diameter than any of the succeeding chambers; sutures distinct, straight, constricted; wall calcareous, hyaline, surface ornamented with about 12 to 13 straight, narrow, longitudinal costae; aperture radiate, terminal, on a short neck.

Length of holotype 0.94 mm, greatest breadth 0.21 mm. Other specimens vary from 0.23 mm to 0.94 mm in length.

Types and occurrence.—Holotype (U.S.N.M. no. 106087) and unfigured paratypes (U.S.N.M. no. 106088) from the Rierdon formation, 55 feet above the base, at locality 1; unfigured paratypes (U.S.N.M. no. 106089) from the Rierdon formation, 134 feet above the base, at locality 5; unfigured paratypes (U.S.N.M. no. 106090) from the Rierdon formation, 15 feet above the base, at locality 2.

Remarks.—This species is similar to *Nodosaria fontinensis* Terquem, but is about one-third smaller, has slightly lower chambers, and considerably more numerous ribs. It differs from *Nodosaria hortensis* Terquem in being nearly one-third larger and in having many more ribs.

Nodosaria sphingothalama Loeblich and Tappan, n. sp.
Pl. 1, figs. 34a–b

Test free, large, stout, elongate, rectilinear; chambers subglobular, increasing gradually in size, numerous, as many as five may be present, although specimens are usually fragmental due to the delicate nature of the test; sutures distinct, straight, strongly constricted, so that the tests are frequently broken at the sutures; wall calcareous, hyaline, surface ornamented with about 22 strong, coarse, straight, longitudinal costae, which are somewhat less prominent at the sutures; aperture terminal, radiate, on a distinct neck.

Length of holotype 0.99 mm, greatest breadth 0.34 mm. Other specimens are from 0.73 mm to 1.27 mm in length.

Types and occurrence.—Holotype (U.S.N.M. no. 106091) and unfigured paratypes (U.S.N.M. no. 106092) from the Rierdon formation, 55 feet above the base, at locality 1; unfigured paratypes (U.S.N.M. no. 106093) from the Rierdon formation, 15 feet above the base, at locality 2.

Remarks.—This species is similar to specimens

figured by Terquem under the name *Nodosaria fontinensis*, but differs in being nearly twice as large and in having fewer but more prominent costae.

Genus **Lingulina** d'Orbigny, 1826

Lingulina charagmata Loeblich and Tappan, n. sp.
Pl. 1, figs. 31a–b

Test free, flattened, of medium size, rhomboidal in outline, periphery subacute; chambers numerous, low and equitant, very highly arched, as many as 10 in large specimens; sutures distinct, forming an acute angle toward the aperture, somewhat elevated and thickened; wall calcareous, hyaline, with fairly large perforations, giving a pitted appearance; aperture terminal, elongate.

Length of holotype 0.52 mm, greatest breadth 0.34 mm, thickness 0.08 mm. Other specimens are from 0.29 mm to 0.73 mm in length.

Types and occurrence.—Holotype (U.S.N.M. no. 106094) and unfigured paratypes (U.S.N.M. no. 106095) from the Rierdon formation, 15 feet above the base, at locality 2; unfigured paratypes (U.S.N.M. no. 106096) from the Stockade Beaver shale member of the Sundance formation, 47 to 52 feet above the base, at locality 4.

Remarks.—This species is similar to *Frondicularia oolithica* Terquem, but is twice as large, has less acutely angled sutures, and a less compressed test.

Lingulina hathra Loeblich and Tappan, n. sp.
Pl. 1, figs. 29a–30

Frondicularia cf. *franconica* Gümbel, Wickenden, Trans. Royal Soc. Canada, ser. 3, sec. IV, **27**: p. 164, pl. 2, fig. 5. 1933.
Frondicularia lingulaeformis Schwager, Wickenden, Trans. Royal Soc. Canada, ser. 3, sec. IV, **27**: p. 164, pl. 2, figs. 4 and 10. 1933.

Test free, large, elongate, flattened, periphery rounded, extremely variable in outline, some specimens elongate with parallel sides, as in the holotype, others palmate with tapered base, and still others comparatively narrow and elongate and almost cylindrical, large suites of specimens showing all gradations between these extremes; equitant chambers increasing gradually in size from the rounded proloculum, low and broad, as many as 10; sutures distinct, slighty depressed or flush with the surface, occasionally slightly constricted; wall calcareous, hyaline, surface ornamented with numerous very fine striae which tend to converge toward the middle of the broad test, at the apertural ends of the chambers; aperture terminal, radiate, on a slight neck.

Length of holotype 1.35 mm, greatest breadth 0.29 mm, greatest thickness 0.18 mm. Other specimens are from 0.36 to 1.35 mm in length.

Types and occurrence.—Holotype (U.S.N.M. No. 106097), figured paratype (U.S.N.M. no. 106098), and unfigured paratypes (U.S.N.M. no. 106099) from the Stockade Beaver shale member of the Sundance formation, 47 to 52 feet above the base, at locality 4; unfigured paratypes (U.S.N.M. no. 106100) from the Rierdon formation, 55 feet above the base, at locality 1; unfigured paratypes from 4,180–4,185 feet (U.S.N.M. no. 106101), 4,195–4,200 feet (U.S.N.M. no. 106102), 4,215–4,220 feet (U.S.N.M. no. 106103), and 4,320–4,325 feet (U.S.N.M. no. 106104), all from cuttings in the Sundance formation at locality 7.

Remarks.—This species differs from *Frondicularia laevissima* Terquem in having lower chambers and in possessing the abundant fine striae. It may be distinguished from *Frondicularia franconica* Gümbel by its slightly larger size, more broadly angled sutures, less flaring test, and less distinct apertural neck. It is differentiated from *Frondicularia lingulaeformis* Schwager in being about six times as large, in having higher chambers, more acutely angled sutures, and a less acuminate base.

Lingulina rursa Loeblich and Tappan, n. sp.
Pl. 1, figs. 32a–b

Test elongate, narrow, tapering, much compressed, periphery sub-acute; chambers numerous, low and broad, equitant, 10 to 13 in large specimens, increasing fairly rapidly in breadth as added in the early part, later increasing more slowly; sutures very slightly depressed, strongly arched centrally, forming an acute angle, somewhat obscure unless specimens are dampened; wall calcareous, hyaline, surface smooth; aperture terminal, elongate.

Length of holotype 0.83 mm, greatest breadth 0.23 mm, greatest thickness 0.08 mm. Other specimens are from 0.26 mm to 0.83 mm in length.

Types and occurrence.—Holotype (U.S.N.M. no. 106105) and unfigured paratypes (U.S.N.M. no. 106106) from 139 feet above the base of the Rierdon formation, unfigured paratypes

(U.S.N.M. no. 106107) from 55 feet above the base of the Rierdon formation, all from locality 1; unfigured paratypes (U.S.N.M. no. 106108) from the Rierdon formation, 15 feet above the base, at locality 2; unfigured paratypes (U.S.N.M. no. 106109) from the Stockade Beaver shale member, 47 to 52 feet above the base, at locality 4; unfigured paratypes from 99 feet above the base (U.S.N.M. no. 106110), 104 feet above the base (U.S.N.M. no. 106111), and 134 feet above the base (U.S.N.M. no. 106112), all from the Rierdon formation at locality 5.

Remarks.—This species is similar to *Frondicularia oolithica* Terquem, but is approximately one-third larger and has less limbate sutures and the test is more compressed.

Genus **Tristix** Macfadyen, 1941

Tristix nitidula Loeblich and Tappan, n. sp.
Pl. 1, figs. 37a–b

Dentalinopsis oölithica ? (Terquem), Wickenden, Trans. Royal Soc. Canada, ser. 3, sec. IV, **27**: p. 167, pl. 2, figs. 6a–b. 1933.

Test free, elongate, narrrow, tapering slightly toward the base, triangular in section, angles rounded; chambers numerous, six in the holotype, increasing very little in height as added except that the final chamber is proportionately larger than earlier chambers; sutures flush with the surface, indistinct unless specimen is dampened, slightly arched in the center of the sides, curving downward at the angles; wall calcareous, hyaline, surface smooth; aperture terminal, rounded.

Length of holotype 0.73 mm, greatest breadth across side 0.23 mm.

Types and occurrence.—Holotype (U.S.N.M. no. 106113) from the Stockade Beaver shale member, 47 to 52 feet above the base, at locality 4.

Remarks.—*Tristix nitidula*, n. sp., differs from *Tritaxia oölithica* Terquem in having a more slender test and more rounded angles, as seen in cross section. It differs from *Tristix liasina* (Berthelin) in being considerably larger and in having more rounded angles.

Genus **Vaginulina** d'Orbigny, 1826

Vaginulina mecyna Loeblich and Tappan, n. sp.
Pl. 1, figs. 38a–b

Test free, elongate, narrow, compressed, triangular in side view; chambers numerous, as many as 12, low and broad, highest dorsally, increasing gradually in breadth as added; sutures distinct, oblique, highest at the dorsal margin, thickened and slightly depressed; wall calcareous, hyaline, surface smooth; aperture terminal at the dorsal angle, on a slight neck-like extension of the final chamber, rounded, but with faint radiate markings.

Length of holotype 1.25 mm, greatest breadth 0.29 mm, greatest thickness 0.10 mm. Other specimens range from 0.65 to 1.38 mm in length.

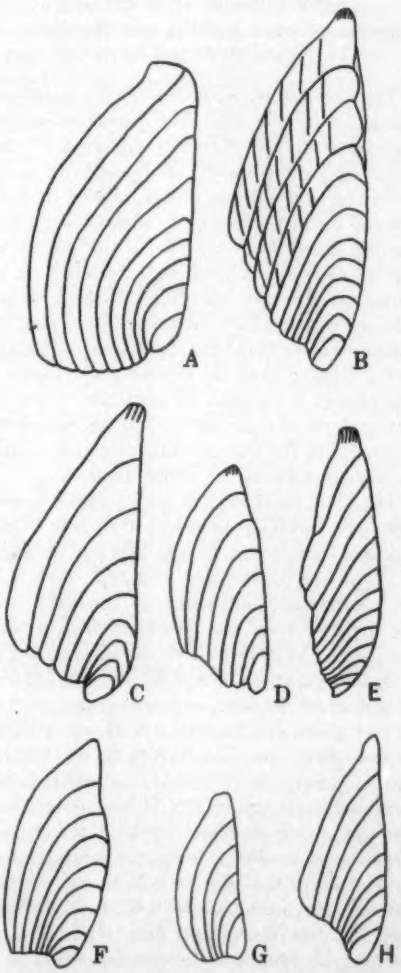

FIG. 2.—*Citharina latissima* Loeblich and Tappan, n. sp., paratypes: A (U.S.N.M. no. 106152), B to H (U.S.N.M. nos. 106155 a–g), showing variation in outline and ornamentation. × 41.

Types and occurrence.—Holotype (U.S.N.M. no. 106148) and unfigured paratypes (U.S.N.M. no. 106149) from the Rierdon formation, 15 feet above the base, at locality 2.

Remarks.—*Vaginulina mecyna*, n. sp., is similar to *Marginulina solida* Terquem var. F of Terquem, but it is about a third larger and has a more tapering base, more numerous chambers, slenderer form, and a more produced final chamber.

Genus **Citharina** d'Orbigny, 1839

Citharina latissima Loeblich and Tappan, n. sp.
Pl. 1, figs. 40a–b; text figs. 2A–H

Test free, large, elongate, much compressed, triangular in side view but varied in outline, periphery truncate; chambers numerous, low and broad, increasing rapidly in breadth as added, increasing very little in height, highest dorsally; sutures distinct, thickened, slightly depressed, curving gently from near the proloculus at the ventral margin to a much higher position on the dorsal margin; wall calcareous, hyaline, surface smooth, except where ornamented by very low and narrow ribs that cross the chambers obliquely and are interrupted by the sutures, number of ribs present is variable, all gradations being observed from smooth tests to those completely covered with the ribs; aperture terminal, radiate, on a short neck at the dorsal angle.

Length of holotype 1.61 mm, greatest breadth 0.60 mm, greatest thickness 0.10 mm. Other specimens range from 0.26 to 2.00 mm in length.

Types and occurrence.—Holotype (U.S.N.M. no. 106150) and unfigured paratypes (U.S.N.M. no. 106151) from the Stockade Beaver shale member, 47 to 52 feet above the base, at locality 4; figured paratype (U.S.N.M. no. 106152) from 33 feet above the base, unfigured paratypes from 55 feet above the base (U.S.N.M. no. 106153), 81 feet above the base (U.S.N.M. no. 106154), figured paratypes (U.S.N.M. no. 106155) and unfigured paratypes (U.S.N.M. no. 106156) from 139 feet above the base, all from the Rierdon formation at locality 1; unfigured paratypes from 99 feet above the base (U.S.N.M. no. 106157), 104 feet above the base (U.S.N.M. no. 106158), and 134 feet above the base (U.S.N.M. no. 106159), all from the Rierdon formation at locality 5.

Remarks.—A few of the variations in outline are shown in the accompanying text figures. This species is similar to *Marginulina condita* Terquem, but the American species differs in having fewer and less prominent costae, and in general the chambers are more overhanging.

Genus **Citharinella** Marie, 1938

Citharinella compara Loeblich and Tappan, n. sp.
Pl. 1, figs. 36a–b; text figs. 3A–D

Test free, elongate, palmate, increasing gradually in size, early portion citharine, later portion frondicularian, periphery subacute; chambers numerous, only three to four citharine chambers followed by as many as seven highly arched equitant chambers that form an acute angle distally; sutures distinct, slightly depressed, strongly oblique in the citharine portion, highly arched in the frondicularian portion; wall calcareous, hyaline, surface smooth, ornamented by numerous very fine low ribs; aperture terminal, radiate, on a slight neck.

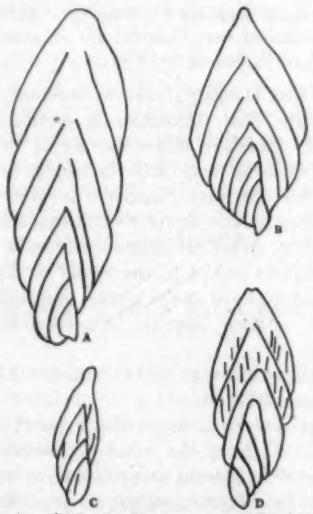

FIG. 3.—*Citharinella compara* Loeblich and Tappan, n. sp., paratypes: A–D (U.S.N.M. nos. 106161a–d), showing variation in outline and ornamentation. × 36.

Length of holotype 1.43 mm, greatest breadth 0.47 mm, greatest thickness 0.10 mm. Other specimens are from 0.39 to 1.43 mm in length.

Types and occurrence.—Holotype (U.S.N.M. no. 106160), figured paratypes (U.S.N.M. nos. 106161a–d), and unfigured paratypes (U.S.N.M. no. 106162) from the Stockade Beaver shale member, 47 to 52 feet above the base, at locality 4; unfigured paratypes from 99 feet above the

base (U.S.N.M. no. 106163) and 134 feet above the base (U.S.N.M. no. 106164), both from the Rierdon formation, at locality 5; unfigured paratypes from 55 feet above the base (U.S.N.M. no. 106165), 139 feet above the base (U.S.N.M. no. 106166), both from the Rierdon formation, at locality 1; unfigured paratypes (U.S.N.M. no. 106167) from the Rierdon formation, 15 feet above the base, at locality 2; unfigured paratype (U.S.N.M. no. 106168) from cuttings at 4,210–4,215 feet in the Sundance formation at locality 7.

Remarks.—*Citharinella compara*, n. sp., is distinguished from *Flabellina jurensis* Franke by its slightly larger size, less arcuate initial portion and its ornamentation of numerous fine ribs.

Citharinella latifolia Loeblich and Tappan, n. sp.
Pl. 1, figs. 35a–b; text figs. 4A–C

Test free, palmate, short and robust, compressed, periphery truncate; chambers numerous, citharine portion reduced, generally consisting of only two or three chambers, followed by as many as six equitant chambers that are much broader but of nearly the same height as the early chambers; sutures distinct, slightly depressed, arched centrally, forming almost a right angle toward the aperture; wall calcareous, hyaline, surface ornamented by numerous rather coarse costae of about the same width as the depressions between costae; aperture terminal, radiate, on a slight neck.

Length of holotype 0.99 mm, greatest breadth 0.47 mm, greatest thickness 0.10 mm. Other specimens are from 0.65 to 1.12 mm in length.

Types and occurrence.—Holotype (U.S.N.M. no. 106169), figured paratypes (U.S.N.M. no. 106170), and unfigured paratypes (U.S.N.M. no. 106171) from the Stockade Beaver shale member, 47 to 52 feet above the base, at locality 4; unfigured paratype (U.S.N.M. no. 106172) from the Rierdon formation, 15 feet above the base, at locality 2; unfigured paratypes (U.S.N.M. no. 106173) from 33 feet above the base and (U.S.N.M. no. 106174) from 55 feet above the base, both from the Rierdon formation, at locality 1.

Remarks.—This species differs from *Flabellina jurensis* Franke in having a much broader test and in being ornamented by rather coarse costae. It differs from *Flabellina karreri* Berthelin in lacking the extremely acuminate early portion and by having chambers which are less strongly recurved.

Genus **Tribrachia** Schubert, 1912

Genotype (here designated).—*Tribrachia inelegans* Loeblich and Tappan, n. sp.

Schubert described the genus *Tribrachia* in 1912, for the tri-radiate frondicularian Foraminifera, but cited no species. As the species *Tribrachia inelegans* Loeblich and Tappan, here described, is the first species to be published in connection with the generic name *Tribrachia*, it thus becomes the genotype. Previously described species that rightfully belong to this genus are *Frondicularia amoena* Reuss and *Frondicularia tricarinata* d'Orbigny. These species were included by ten Dam and Schijfsma in the genus *Tricarinella*, which is, however, a synonym of *Tristix* Macfadyen. *Tristix* and *Tribrachia* are quite distinct, the former having the appearance of a triradiate *Lingulina* whereas the latter is more similar to a triradiate *Frondicularia*.

Cushman (1948: 219) stated that "some of the Cretaceous species [of *Frondicularia*] have a supplementary angle and have been named *Tribrachia* by Schubert. The name may perhaps be used for these specialized species." Galloway (1933: 242) included *Tribrachia* in the synonomy of *Frondicularia* as "monstrosities with three edges." The writers believe Schubert's genus to be distinct from *Frondicularia*. In the Rierdon formation we have seen no species of true *Frondicularia*, and thus the species here described cannot be merely a monstrosity. We have also seen true *Tribrachia* in the American Cretaceous. Although in some horizons we have seen specimens with a third angle which were obviously monstrosities of *Citharinella*, *Palmula* and *Frondicularia*, these freakish specimens merely suggest a relationship between these lagenid genera. The occurrence of

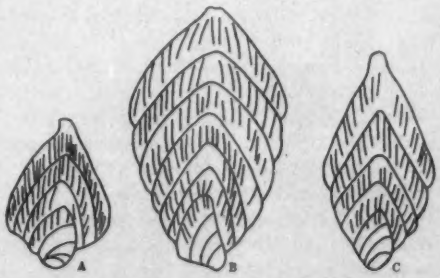

FIG. 4.—*Citharinella latifolia* Loeblich and Tappan, n. sp., paratypes: A–C (U.S.N.M. nos. 106170-a–c), showing variation in plan, outline, and ornamentation. × 36.

Tribrachia not associated with any of these genera establishes the validity of the genus.

Tribrachia inelegans Loeblich and Tappan, n. sp.
Pl. 1, figs. 39a–b

Test free, elongate, tapering, triangular in section, angles truncate; about six chambers, each trifoliate in section, with sides of each radius nearly parallel, chambers increasing in breadth as added but only slightly in height; sutures distinct, depressed, very highly arched near the central portion of the test, curving far backward toward the proloculus at the angles; wall calcareous, hyaline, surface smooth; aperture terminal, radiate.

Length of holotype 0.91 mm, greatest breadth 0.34 mm. Length of paratype 1.17 mm, greatest breadth 0.36 mm.

Types and occurrence.—Holotype (U.S.N.M. no. 106175) and unfigured paratype (U.S.N.M. no. 106176) from the Rierdon formation, 134 feet above the base at locality 5.

Remarks.—*Tribrachia inelegans*, n. sp., differs from *Frondicularia tricarinata* d'Orbigny in having a somewhat smaller and comparatively broader test. It is differentiated from *Frondicularia amoena* Reuss by its broader test and more acutely angled sutures.

Family SPIRILLINIDAE

Genus **Turrispirillina** Cushman, 1927

Turrispirillina spirella Loeblich and Tappan, n. sp.
Pl. 1, figs. 41a–b

Cornuspira orbicula (Terquem and Berthelin), Sandidge, Amer. Midland Nat. **14:** 178, pl. 1, fig. 14. 1933.

Test free, small, consisting of a proloculus and elongate, tubular, evolutely coiled second chamber that forms a low conical spire, concave ventrally; spiral suture distinct; wall calcareous, hyaline, surface smooth; aperture rounded, at the end of the tube.

Greatest diameter of holotype 0.29 mm, greatest thickness 0.05 mm. Other specimens are from 0.16 mm to 0.29 mm in diameter.

Types and occurrence.—Holotype (U.S.N.M. no. 106177) and unfigured paratypes (U.S.N.M. no. 106178) from the Rierdon formation, 15 feet above the base, at locality 2.

Remarks.—This species is probably the same as that recorded by Sandidge, but our specimens are not as large. It differs from *Spirillina orbicula* Terquem and Berthelin in being conically spiral rather than planispirally coiled; otherwise the two are very similar.

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EXPLANATION OF PLATE 1

1, 2.—*Ammodiscus cheradospirus* Loeblich and Tappan, n. sp.: 1, Side view of holotype (U.S.N.M. no. 106014), showing regular, evolutely planispiral coil; 2a, side view of paratype (U.S.N.M. no. 106015); 2b, edge view. × 36.

3, 4.—*Frankeina commutata* Loeblich and Tappan, n. sp.: 3a, Side view of holotype (U.S.N.M. no. 106017), showing large and prominent coil followed by triangular uniserial portion of less diameter; 3b, top view, showing rounded aperture; 4, side view of young paratype (U.S.N.M. no. 106021), showing coiled portion and initial portion of uniserial stage. × 20.

5–8.—*Lenticulina dilecta* Loeblich and Tappan, n. sp.: 5a, Side view of paratype (U.S.N.M. no. 106027a), showing trochoid character occasionally seen in this species; 5b, opposite side of trochoid paratype; 6, side view of paratype (U.S.N.M. no. 106027b), showing elevated sutures; 7a, side view of holotype (U.S.N.M. no. 106026), showing elevated sutures and depressed umbilicus with encircling ridge formed by coalescing ends of the sutures; 7b, edge view, showing peripheral keel and flattened apertural face; 8, side view of paratype (U.S.N.M. no. 106027c) showing elevated sutures with minute projecting lateral spines. × 36.

9–13.—*Vaginulinopsis eritheles* Loeblich and Tappan, n. sp.: 9a, Side view of holotype (U.S.N.M. no. 106066), showing typical megalospheric characters; 9b, edge view, showing peripheral keel; 10, side view of paratype (U.S.N.M. no. 106067a), showing rare development of *Nodosaria*-like uniserial chambers; 11, microspheric

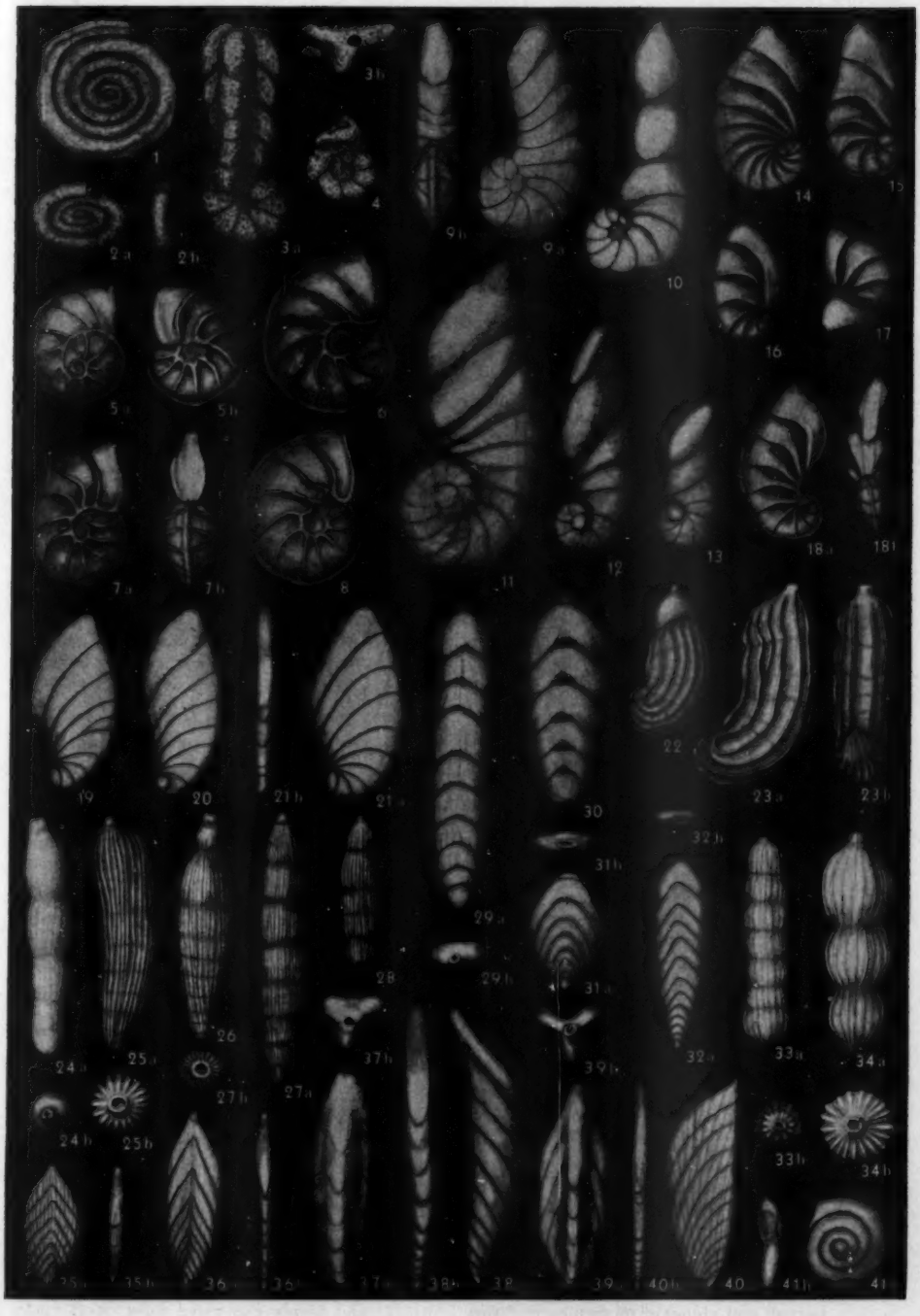

PLATE 1.—(For explanation see pages 16, 18, 19).

paratype (U.S.N.M. no. 106067b), showing large coil, and distinctly depressed sutures in the uniserial portion; 12, side view of paratype (U.S.N.M. no. 106067c), showing a more irregular development of the uniserial chambers; 13, side view of paratype (U.S.N.M. no. 106067d), a small megalospheric individual. × 36.

14–18.—*Astacolus ectypus* Loeblich and Tappan, n. sp.: 14, Side view of paratype (U.S.N.M. no. 106036a), showing auriculate outline; 15, side view of paratype (U.S.N.M. no. 106036b), showing elongate test; 16, side view of paratype (U.S.N.M. no. 106036c), showing large amount of overlap in final chamber; 17, side view of "twinned" paratype (U.S.N.M. no. 106039); 18a, side view of holotype (U.S.N.M. no. 106035), showing depressed sutures bordered anteriorly by a sharp ridge formed by the inflation of the chamber; 18b, edge view, showing peripheral keel, deeply depressed sutures and truncate apertural face. × 36.

19–21.—*Astacolus petalus* Loeblich and Tappan, n. sp.: 19, Side view of paratype (U.S.N.M. no. 106046a) showing broad and low chambers; 20, side view of paratype (U.S.N.M. no. 106046b), showing narrower form; 21a, side view of holotype (U.S.N.M. no. 106045), showing auriculate outline and smooth character of the test; 21b, edge view, showing even thickness throughout length. × 36.

22, 23.—*Marginulinopsis phragmites* Loeblich and Tappan, n. sp.: 22, Side view of paratype (U.S.N.M. no. 106052), showing unornamented final chamber; 23a, side view of holotype (U.S.N.M. no. 106051), showing indistinct sutures and prominent costae traversing the length of the test; 23b, edge view. × 36.

24.—*Dentalina gracilistriata* Loeblich and Tappan, n. sp.: 24a, Side view of holotype (U.S.N.M. no. 106074), showing slightly arcuate test, nearly horizontal sutures, and fine striae; 24b, top view. × 48.

25.—*Dentalina ochyra* Loeblich and Tappan, n. sp.: 25a, Side view of holotype (U.S.N.M. no. 106075), showing indistinct sutures and coarse ribs; 25b, top view. × 36.

26–28.—*Dentalina polyholca* Loeblich and Tappan, n. sp.: 26, Side view of paratype (U.S.N.M. no. 106083a), showing tapering of test at both ends; 27a, side view of holotype (U.S.N.M. no. 106081), showing nearly horizontal sutures and abundant striae; 27b, top view; 28, side view of small paratype (U.S.N.M. no. 106083b), showing less acuminate base. × 36.

29, 30.—*Lingulina hathra* Loeblich and Tappan, n. sp.: 29a, Side view of holotype (U.S.N.M. no. 106097), showing comparatively narrow and elongate microspheric form; 29b, top view, showing terminal and faintly radiate aperture; 30, side view of paratype (U.S.N.M. no. 106098), showing broader and shorter megalospheric form. × 36.

31.—*Lingulina charagmata* Loeblich and Tappan, n. sp.: 31a, Side view of holotype, (U.S.N.M. no. 106094), showing rhomboidal outline and limbate highly arched sutures; 31b, top view, showing compressed form and elongate aperture. × 36.

32.—*Lingulina rursa* Loeblich and Tappan, n. sp.: 32a, Side view of holotype (U.S.N.M. no. 106105), showing narrow elongate form and sharply angled sutures; 32b, top view, showing subacute margins and elongate aperture. × 36.

33.—*Nodosaria orthostoecha* Loeblich and Tappan, n. sp.: 33a, Side view of holotype (U.S.N.M. no. 106087), showing narrow elongate test and subglobular chambers of approximately equal diameter; 33b, top view, showing numerous ribs and terminal aperture. × 36.

34.—*Nodosaria sphingothalama* Loeblich and Tappan, n. sp.: 34a, Side view of holotype (U.S.N.M. no. 106091), showing large inflated chambers, constricted sutures, and continuous ribs; 34b, top view, showing numerous ribs and radiate aperture. × 36.

35.—*Citharinella latifolia* Loeblich and Tappan, n. sp.: 35a, Side view of holotype (U.S.N.M. no. 106169), showing abbreviated early *Citharina*-like portion and coarse striae covering the test; 35b, edge view, showing bulbous early portion. × 20.

36.—*Citharinella compara* Loeblich and Tappan, n. sp.: 36a, Side view of holotype (U.S.N.M. no. 106160), showing small citharine stage followed by acutely angled frondicularian chambers with surface ornamentation consisting of fine striations; 36b, edge view, showing uniform thickness of the test. × 20.

37.—*Tristix nitidula* Loeblich and Tappan, n. sp.: 37a, Side view of holotype (U.S.N.M. no. 106113), showing moderately excavated sides and rounded angles; 37b, top view, showing terminal rounded aperture and rounded angles. × 48.

38.—*Vaginulina mecyna* Loeblich and Tappan, n. sp.: 38a, Side view of holotype (U.S.N.M. no. 106148), showing triangular form, oblique sutures, and necklike extension of the final chamber; 38b, edge view. × 36.

39.—*Tribrachia inelegans* Loeblich and Tappan, n. sp.: 39a, Side view of holotype (U.S.N.M. no. 106175), showing deeply excavated sides and acutely angled sutures; 39b, top view, showing aperture and deeply excavated sides. × 36.

40.—*Citharina latissima* Loeblich and Tappan, n. sp.: 40a, Side view of holotype (U.S. N.M. no. 106150), showing low and broad chambers, thickened sutures, and low narrow ribs; 40b, edge view, showing compressed form. × 20.

41.—*Turrispirillina spirella* Loeblich and Tappan, n. sp.: 41a, Dorsal view of holotype (U.S.N.M. no. 106177), showing globular proloculus and long, undivided second chamber; 41b, edge view, showing very low spire. × 48.

BOTANY.—Ectosperma, *a new genus of grasses from California.*[1] JASON R. SWALLEN, U. S. National Museum.

A very unusual and striking grass was collected by Miss Annie M. Alexander and Miss Louise Kellogg in the course of exploration in Inyo County, California, early last summer. It was submitted to the author for identification by Dr. H. L. Mason, of the University of California. It was evident at once that the grass did not belong to any species known from the United States, and on further examination it proved to be not only a new species but a new genus. One of the characters is the free caryopsis which falls from the floret very early and easily, sometimes even before it is entirely mature. The generic name selected refers to this character.

Ectosperma Swallen gen. nov.

Spiculae paniculatae 3–7-florae, rachilla continua; glumae subaequales, spicula paulo breviores, 7–11-nerves; lemmata 5–7-nervia, exaristata, marginibus in parte inferiore dense vilosa; palea lemma aequans, tenuis, ovata, truncata, nervis minute excurrentibus, marginibus latis dense villosa; caryopsis decidua; stylorum bases persistentes; hilum circulare, depressum; embryo latus ellipticus, caryopsi ⅓ brevior; styli elongati, stigmatibus plumosis.

Spikelets 3–7-flowered, the rachilla continuous, the florets persistent, crowded, successively smaller; glumes subequal, nearly as long as the florets, spreading, 7–11-nerved, some of the nerves faint; lemmas 5–7-nerved, awnless, densely villous on the margins in the lower half, sometimes also on the internerves; palea as long as or a little longer than the lemma, thin, broad, ovate, the broad margins densely villous with long hairs nearly to the summit, sparsely villous on the back at the base, the apex erose-truncate, the nerves excurrent in short awns; caryopsis readily falling from the floret, elliptic, roughly rectangular in cross section, the style bases persistent as short points; hilum circular, depressed; embryo broad, elliptic, nearly two-thirds the length of the grain; styles elongate with the stigmas plumose on all sides; stamens 3.

Stiff perennial, apparently with long underground stems or rhizomes, relatively short, flat, stiff blades, and narrow, simple panicles of large, pale hairy spikelets.

Ectosperma alexandrae Swallen, sp. nov.

Culmi erecti, rhizomatosi (?), ramis fertilibus et sterilibus praediti; rami steriles internodiis breviibus nodis lanato-villosis et foliis densis instructi; rami fertiles graciliores, internodiis superioribus elongatis; vaginae dense ciliatae in ore et collo villosae vel eae remorum fertilium subglabrae; ligula 1 mm. longa, dense ciliata; laminae 4–14 cm longae, 3–6 mm latae, acuminatae, nervosae, glabrae, vel supra scaberulae; paniculae 4–10 cm longae, ramis brevibus, appressis, 1–3-spiculatis; spiculae 1–1.5 cm longae; glumae 9–14 mm longae, acuminatae, glabrae; lemma primum 8–9 mm longum, acutum vel mucronatum; caryopsis 4 mm longa, 2 mm lata, fusca; antherae 3.5 mm longae.

Culms erect with sterile and fertile branches; sterile branches stout with short internodes, lanate-villous nodes, and crowded leaves, the fertile ones more slender, at least the upper internodes elongate; sheaths rounded, densely ciliate, villous at the throat and on the collar, or those of the flowering branches nearly glabrous; ligule 1 mm long, densely ciliate; blades 4–14 cm long, 3–6 mm wide, acuminate, strongly nerved, glabrous, or scaberulous on the upper surface; panicles 4–10 cm long, the branches short, appressed, bearing 1–3 spikelets; spikelets 1–1.5 cm long, nearly as wide; glumes 9–14 mm long, acuminate, glabrous; first lemma 8 mm long, acute or mucronate; caryopsis 4 mm long, 2 mm wide, brown; anthers 3.5 mm long.

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FIG. 1.—*Ectosperma alexandrae* Swallen, gen. et sp. nov.

Type in the U. S. National Herbarium, no. 1963637, collected on lower slopes of big sand hill, Eureka Valley, Inyo County, California, alt. 3,050 feet, May 24, 1949, by Annie M. Alexander and Louise Kellogg (no. 5655).

Regarding the locality Miss Alexander writes: "The sand hill stands over 600 feet higher than the floor of the valley and is a ghostly looking mound seen from a distance. The dense tussocks of the coarse grass, scattered here and there, were growing for a short distance up the north slope . . . the roots were deeply imbedded in the sand."

This genus belongs to the tribe Festuceae, although the glumes are nearly as long as the spikelet, which might indicate some affinity with the Aveneae. The characters are so distinctive that it is difficult to determine its actual relationship in the tribe. The appearance of the spikelets suggests *Tridens*, but the characters are completely different.

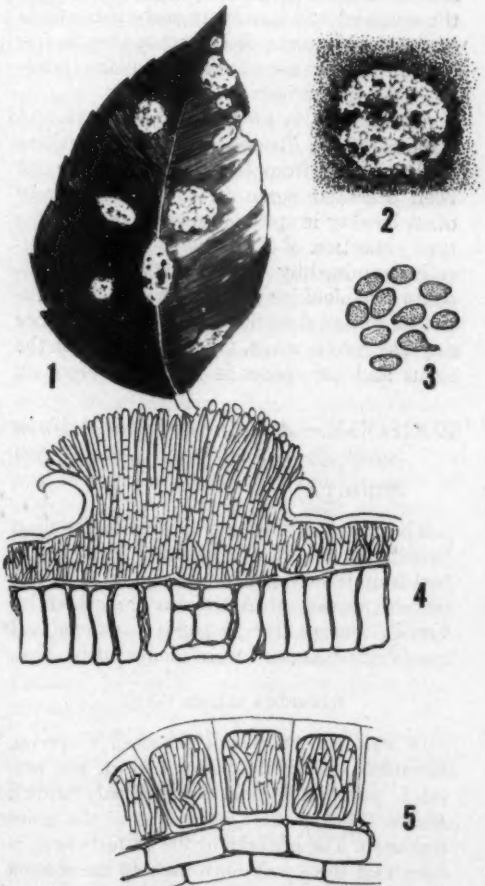
MYCOLOGY.—Elsinoë viticola *from India.*[1]

M. J. THIRUMALACHAR, Hindu University, Benares, India. (Communicated by ANNA E. JENKINS.)

During the course of the studies on spot anthracnoses in Mysore, South India, collections were made on *Tetrastigma sulcatum* Gamb. near Kemmangundi at an altitude of 4,800 feet above sea level. *T. sulcatum* is a climbing shrub belonging to the Vitaceae developing pedately compound leaves. The infection spots were noticed on the leaves in the form of circular patches. A cursory study indicated that the fungus was identical with *Elsinoë viticola* Racib. described by Raciborski (1900) from Java on *Tetrastigma coriaceum* (= *Vitis coriacea*), an account of which is presented by Bitancourt and Jenkins (1943).

The infection patches on the lamina of *Tetrastigma sulcatum* are at first chalky white with a corrugated surface. They are circular with sinuous outline, slightly more elevated than the leaf surface and coalescing with one another when in close juxtaposition. Some of the infection patches involving the midrib or the veinlets are more linear or elongated in outline, showing a tendency to spread in the same direction as the veins (Fig. 1). In older stages the infection patches gradually turn grayish brown with islands of black patches (Fig. 2). Raciborski described the infection patches bearing the ascomata of *E. viticola* as being chocolate-brown in color, and Arnaud (1925) described it as superficially resembling the patches of the parasitic alga *Cephaleuros virescens*.

Sections through the young infection indicated the *Sphaceloma* stage of the fungus, which is so far unknown. The initials of the acervuli are formed by the grouping of the



FIGS. 1–5.—1, Leaflet of *Tetrastigma sulcatum* showing infection spots of *Elsinoë viticola*, about three-fourths natural size; 2, enlarged view of the infection spot, × 2½; 3, conidia, × 750; 4, acervulus, × 300; 5, development of sori initials within the epidermis, × 300.

[1] Received October 7, 1949.

hyphal strands within the epidermis (Fig. 5). Several epidermal cells in a row are involved and a large stroma is formed. These epidermal cells enlarge in size and very soon the upper wall ruptures exposing the conidial stroma (Fig. 4). The conidia (Fig. 3) are produced in abundance acrogenously and these are ovate to spherical, thin-walled, hyaline, measuring 4.5–6 by 4–4.5μ.

The infection patch presents a whitish appearance when the conidia are abundant. As it turns grayish white with black patches, no more conidia can be observed and the stroma becomes large and pulvinate. Though the material was immature early indications of the development of asci were seen in few cases, and further studies are being made to study the ascigerous stage.

As already reviewed by Bitancourt and Jenkins (1943), *Elsinoë viticola* was described by Raciborski from Java and has so far not been collected again in the same or any other locality in spite of repeated search. The type collection of *E. viticola* has been critically examined by Arnaud (1925) and Bitancourt and Jenkins (1943), but on the particular material sectioned all failed to notice any ascigerous stage. Our knowledge of the ascus and ascospores is based therefore on the descriptions given by Raciborski. In the sections through the stroma of *E. viticola* collected by Raciborski, Bitancourt and Jenkins found other saprophytes such as *Phyllosticta* sp., and only hyaline hyphae typical of *Elsinoë* could be made out. *Sphaceloma* stage of the fungus was so far unknown.

The present collection of the fungus on *Tetrastigma sulcatum* from Mysore is the first record to be made outside the type locality in Java. It is also of interest because attempts to recollect the fungus in the type locality since Raciborski's record of it have been unsuccessful (cf. Bitancourt and Jenkins, 1943). Another Elsinoaceae on Vitaceae described from the Eastern Hemisphere is *Elsinoë cissi* Jenkins and Bitancourt (1946) on *Cissus* sp. from Uganda.

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ZOOLOGY.—*A revision of some Actiniaria described by A. E. Verrill.*[1] OSKAR CARLGREN, Zoological Institution, Lund, Sweden. (Communicated by WALDO L. SCHMITT.)

Through the kindness of the Smithsonian Institution and the American Museum of Natural History, I have been able to revise certain species of Actiniaria described by Verrill. Except for *Sagartia leucolena*, all specimens examined were identified by him.

Edwardsia sulcata Verrill

In 1864 (p. 29) Verrill described a species, *Edwardsia sulcata*, the body of which was provided with 12 distinct longitudinal furrows. Andres (1883, p. 317) referred it to the genus *Halcampa*. The presence of the 12 furrows indicates that there may have been 12 mesenteries the whole length of the body. Taken for granted that the description made by Verrill is correct, his species can not be ranged in the genus *Edwardsia*. The holotype is probably lost, but in the collection of the Smithsonian Institution there is a specimen labeled "*Edwardsia sulcata?* Gloucester Mass. Verrill id." [identified]. This specimen is an *Edwardsia* with well-developed physa and eight deep, longitudinal furrows. The nemathybomes are collected in the middle line between the furrows but fairly irregularly in each compartment. It is probable that this displacement is caused by the very strong contraction of the body, but in any case the nemathybomes are apparently not scattered. I counted 14 tentacles, and there are probably never more than 16. The retractors (Fig. 1*a*) are strong, rather restricted with about 20 folds, several of them branched. The parietal muscles (Fig. 1*b*) are strong, though their distribution on the body wall is impossible to determine owing to the strong contraction and poor preservation of the specimen. The

[1] Received June 6, 1949.

nematocysts of the nemathybomes are partly 84.6–104.3 by about 7μ, partly 52.2–67.7 by 4.2μ; those of the tentacles 21–26.8 by 2.8–3.5μ (basitrichs); those of the filaments partly 24–28.2 by 4.5–7μ (microbasic *p*-mastigophors), partly 19.7–22.6 (25.4) by 2.5–2.8 (3.5)μ (basitrichs).

Drillactis pallida (Verrill)

Edwardsia pallida Verrill, 1879, p. 198.
Halcampa pallida (Verrill) Andres, 1883, p. 317.
Drillactis pallida (Verrill) Verrill, 1922, p. 133G, pl. 21, figs. 4, 4a.

Unfortunately the cotype examined by me is rather badly preserved. The actinopharynx is everted and the tentacles pressed together, and therefore it is very difficult to decide whether the smaller tentacles are situated inside the larger or vice versa. I have made cross sections of the lower and upper part of the very long body. There are probably no nemathybomes. Since the mesenteries are arranged as in *Edwardsia*, the microcnemes are present only in the uppermost part of the body. Fig. 2 shows sections of a macrocnema (*a*) and of a parietal muscle (*b*) in the upper region of the body. The muscle folds of the retractor are few, the outer and inner branched; the parietal muscle is fan-shaped, weak, its distribution on the body wall considerable. In the lower part of the body the retractors of the directives are weaker than those of the other macrocnemes. The nematocysts of the column are 8.5–14 by about 1.5μ (basitrichs); those of the tentacles 14–19 by 2–2.5μ (basitrichs); those of the actinopharynx partly 10–12.7 by 2–2.5μ often a little curved, partly 17–22.6 by 2.5–3 (3.5)μ (both basitrichs); those of the filaments partly 10–14 by 2.2–2.8μ (basitrichs), partly 8.5–13 by 3.5μ (probably microbasic *p*-mastigophors—the filaments are badly macerated).

The genus is certainly nearly related to *Nematostella*, but an examination of fresh material is necessary in order to clear up their relation to each other. It is not identical with *Milne-Edwardsia akkeshi* Uchida, a species that may be referred to a new genus, *Metedwardsia* (Carlgren, 1947, p. 1).

Cladactella manni (Verrill)

Bunodactis manni Verrill, 1899c, p. 218.
Tealiopsis manni (Verrill), Verrill, 1922, p. 110G.
Cladactella manni (Verrill), Verrill, 1928, p. 22, fig. 3, a, c, pl. 4, fig. c.

I have examined a specimen, certainly the same one of which a photo is reproduced on plate 4c of Verrill's paper of 1928. Verrill (1928, p. 22) has given a good description of the exterior and some notes about the inner organization. His statement that the species is devoid of a sphincter is, however, erroneous; the species has a well-developed diffuse sphincter (Fig. 3*a*). The longitudinal muscles of the tentacles and the radial muscles of the oral disc (Fig. 3*b*) are ectodermal. There are considerably more mesenteries at the base than at the margin. The retractors of the mesenteries are very weak, forming low folds in the inner parts of the mesenteries. The parietobasilar muscles form a distinct projection on the stronger mesenteries. The nematocysts of the vesicles are 15.5–18.3 by 2.5–3μ (basitrichs); those of the tentacles 17–21 by 2.5–2.8μ (basitrichs); those of the actinopharynx 24–28 by 2.5–2.8μ (basitrichs); those of the filaments partly 19.7–28.2 by 3.5–4.2μ (basitrichs), partly 15.5–18.3 by 3.5–4.2μ (microbasic *p*-mastigophors).

The genus *Cladactella* may be characterized as follows: Pedal disc broad. Column cylindrical, entirely covered with round or elliptical vesicles very closely set. Fosse rather shallow. Sphincter well developed, diffuse, rather broad. No marginal spherules, no pseudospherules. Tentacles up to about 96, of moderate length, conical, imperfectly retractile. Longitudinal muscles of tentacles and radial muscles of oral disc ectodermal. Two well-developed siphonoglyphs and two pairs of directives. Numerous perfect pairs of mesenteries. Considerably more mesenteries at the base than at the margin. Retractors diffuse, very weak, parietobasilar muscles well developed. Distribution of the gonads imperfectly known but they are seemingly borne on the imperfect mesenteries and on many of the perfect ones. Cnidom: spirocysts, basitrichs, and microbasic *p*-mastigophors.

The genus is nearly related to *Phlyctenactis* (*Cystiactis*), but that genus has mesogloeal muscles in the tentacles and oral disc.

Diadumene leucolena (Verrill)

Sagartia leucolena Verrill, 1866, p. 366; 1873, p. 329, pl. 38, fig. 284; 1898, p. 495; 1899c, p. 208, fig. 29.
Cylista leucolena (Verrill) Andres, 1883, p. 365; Parker, 1900, p. 755, fig. 17; Hargitt, 1914, p. 243, pl. 43, fig. 8, pl. 44, fig. 11.

Two specimens collected by Hargitt and ex-

amined by me are undoubtedly *Sagartia leucolena* Verrill. I have sectioned parts of a specimen and examined the nematocysts. The species is, however, no *Sagartia* but a *Diadumene*. The column is indistinctly divisible into a longer scapus and a shorter capitulum. There is no sphincter. The tentacles are divisible into catch tentacles and common ones. I cannot decide the number of the former, because they are not distinctly distinguished from the latter, but they are histologically differentiated inasmuch as their tips are provided with the characteristic nematocysts. According to Hargitt the inner tentacles move in the same characteristic manner as those of *Diadumene cincta* (Carlgren, 1929, p. 110). Hargitt writes (1914, p. 243–244), "It was not unusual to find at certain times that one or even several of the tentacles of the inner series might become more or less specialized at times, apparently serving as tactile organs, being greatly extended and vigorously vibrated in various directions." The longitudinal muscles of tentacles are ectodermal. There are, as in Hargitt's specimen, six pairs of perfect mesenteries typically arranged. The retractors (Fig. 4) of the perfect mesenteries are rather strong, the parietobasilar muscles weak. There are more mesenteries distally than proximally. The nematocysts of the column are partly 12.7–19 by about 2μ (basitrichs), partly 12.7–19.7 by 3.5–4.2μ (microbasic amastigophors); those of the tips of the catch tentacles partly 22.6–28.2 by 6.3–7μ (atrichs, common) partly 17.6–24.7 by 3–4.2μ (holotrichs, common), partly 19.7–26.2 by 4.5μ (*p*-mastigophors or amastigophors); those of the outer tentacles partly 15.5–18.3 by 2–2.8μ (basitrichs), partly 21–24 by 4–4.5μ (probably *p*-mastigophors); those of the actinopharynx partly 14.8–18.3 by about 2μ (basitrichs), partly 21–24 by 3.5–4.5μ (microbasic *p*-mastigophors); those of the filaments partly 8.5–14.1 by 3.5–4μ (*p*-mastigophors), partly 24–28.2 by 4.2–5μ (microbasic amastigophors); those of the acontia partly 26.8–39.5 (commonly 36.5–38) by 7–8.5μ (microbasic *p*-mastigophors), partly 13–16.2 by about 1.5μ (basitrichs). I have not found any macrobasic amastigophors in the few outer tentacles examined, but this is not significant since these nematocysts are rare and do not occur in all common tentacles of *Diadumene cincta*. An examination of a multitude of tentacles may probably show their existence in *leucolena*.

Sagartia spongicola Verrill

Sagartia spongicola Verrill, 1883, p. 47, pl. 6, fig. 3; 1885, p. 534, pl. 7, fig. 200; McMurrich, 1898, p. 238, pl. 2, figs. 3, 4.

I have examined three specimens from Marthas Vineyard. All show an irregular arrangement of the mesenteries indicating that the species may propagate asexually. In two specimens there are nine pairs of perfect mesenteries among which four pairs of directives arranged d.1, d.1, d.1, d.1.1; in the third six perfect pairs, three directives and alternating with these three common pairs. The retractors of the perfect mesenteries are very strong, often circumscribed, sometimes the retractors belonging to the same pair have a somewhat different appearance (Fig. 5*b*). The parietobasilar muscles are well developed, forming a distinct projection on the mesenteries. The imperfect mesenteries are weak as shown in Fig. 5*c*, representing a mesentery of the second cycle from the same slide as the retractors. Probably these mesenteries lack filaments, but owing to the bad preservation of the specimens it is difficult to say if it is really so. The sphincter (Fig. 5*a*) is not strong, showing a distinct tendency to transverse stratification. The longitudinal muscles of the tentacles are ectodermal. The nematocysts of the column are partly 10–12.7 by 1.5–2.2μ (basitrichs), partly 19.7–28.2 by 2.8–3.5μ, partly 31–39 by 4.2–5.6μ (both probably basitrichs). The identification, however, of the nematocysts is not sure because they are very opaque. Moreover there are nematocysts of uncertain type 17–21 by about 4.2μ somewhat broader in their basal end; those of the tentacles 24–28.9 by 3–3.5μ (basitrichs); those of the actinopharynx partly 26.8–32.4 by 2.8–3.5μ (basitrichs), partly 15.5–22.6 by 4.2μ (microbasic *p*-mastigophors); those of the filaments partly 12.7–16.9 by 2.2–2.5μ (basitrichs), partly (12.7) 15.5–19.7 by 3.5–4.2μ (microbasic *p*-mastigophors); those of the acontia 33.8–39.5 by 3–4μ (basitrichs). Already Verrill's statement (1883) that "there are a few small, pit-like openings on the sides, which appear to be pores (cinclidae)" and that "some specimens show small verrucae [papillae] near the summit" indicates that the species may belong to another genus than *Sagartia*. The species is a hormatiid. As the tentacles seem to be some more numerous, or in any case not fewer than the mesenteries at the base, the species may be a *Stephanauge*, though it differs from other known species of the genus inasmuch as it has

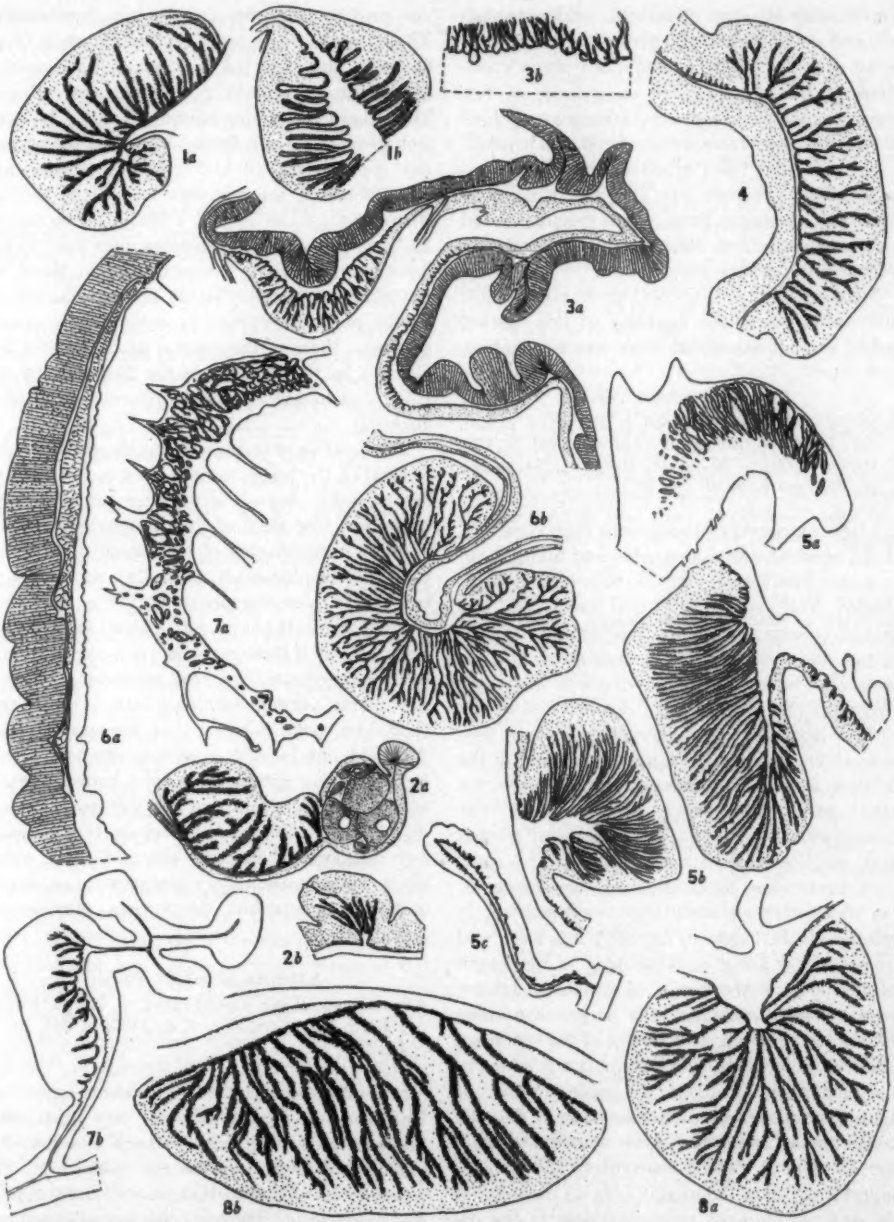

FIG. 1.—*Edwardsia sulcata* Verrill: *a*, Retractor; *b*, parietal muscle. FIG. 2.—*Drillactis pallida* (Verrill): *a*, Retractor and macroneme; *b*, parietal muscle. FIG. 3.—*Cladactella manni* (Verrill): *a*, Sphincter; *b*, radial muscle of oral disc. FIG. 4.—*Diadumene leucolena*, retractor. FIG. 5.—*Sagartia spongicola* Verrill: *a*, Sphincter; *b*, two retractors; *c*, mesentery of second cycle. FIG. 6.—*Sagartia modesta* Verrill: *a*, Sphincter; *b*, retractor. FIG. 7.—*Adamsia sociabilis* Verrill: *a*, Sphincter; *b*, retractor. FIG. 8.—*Bunodosoma grandis* (Verrill): *a*, *b*, Sphincters.

considerably stronger retractors, weaker sphincter, and an irregular arrangement of the mesenteries. Verrill (1897) has examined seven specimens of this species. The mesenteries of two specimens show a hexamerous arrangement, those of two other specimens are arranged on a heptamerous plan and three specimens on an octamerous. The directives are two but irregularly set in one specimen, three in five specimens, and four in one specimen. This variability is certainly joined with asexual propagation.

McMurrich (1898, p. 238) gave considerable information as to the anatomy of this species, but he was not sure about its systematic position.

Sagartia modesta Verrill

Sagartia modesta Verrill, 1866, p. 337; 1873, p. 330, 738; 1899b, p. 146, fig. 19; Andres, 1883, p. 193; Parker, 1900, p. 755, fig. 16; Hargitt, 1914, p. 240, pl. 42, figs. 5, 6, pl. 43, fig. 7.

I have examined two specimens from Newport, R. I., of which one is expanded and about 5 cm long and 2 cm broad, and the other strongly contracted. The pedal disc is well developed. The smooth column is probably divisible into a thicker scapus and a thinner short capitulum. Verrill's note also indicates such a division. He says: "When partly contracted, a distinct fold of the surface near the upper margin sometimes projects above the disc." The uppermost part of the column is also considerably thinner than the other parts. The margin is tentaculate. The mesogloeal sphincter (Fig. 6*a*) forms small meshes and occupies most of the mesogloea. It is situated nearer the ectoderm than the endoderm. On slides it seems fairly well developed but in relation to the length of the body it is weak and occupies only about one-seventieth of the length of the body in the expanded specimen. I have more closely examined the larger specimen. Owing to the strong contraction of the tentacles, it is very difficult to count them, but it seems to me that there is about the same number of tentacles and mesenteries at the base, or that the tentacles are somewhat more numerous. There are 42 pairs of mesenteries present at the base; about 2 cm from the margin only 51 mesenteries (6 + 6 + 12 + 1½ pairs). Apparently the development of mesenteries takes place about simultaneously from the margin and from the limbus. There are two pairs of directives, the two first cycles of mesenteries are perfect (as indicated by the contracted specimen). The retractors are present only on the perfect mesenteries. Those on the mesenteries of the first cycle (Fig. 6*b*) reach almost to the base, those of the second cycle disappear about 2 cm from the margin. The other mesenteries are very weak. The perfect mesenteries are fertile. The nematocysts of the column are 10–11.5 by 2.5μ (basitrichs, rare); those of the tentacles 12.7–17 by 2–2.5μ (basitrichs); those of the actinopharynx partly 21–24 by about 2.8μ (basitrichs), partly 21–25 by 3.5–4.5μ (microbasic *p* mastigophors); those of the filaments partly 15.5–24 by 2.2–2.5μ (basitrichs), partly 21–24 by 8.2μ (microbasic *p*-mastigophors); those of the acontia partly 14–19.7 by about 2.5μ (basitrichs), partly 26.8–33.8 by 4–5.5μ (microbasic *p*-mastigophors or amastigophors).

The position of this species is difficult to decide. Several of the larger nematocysts in the acontia are exploded, but all shafts seem to be wholly destroyed. The shaft of the unexploded capsules is about three-fourths of the length of the capsules, which indicates that the capsules are microbasic *p*-mastigophors. But the amastigophors may rarely have a rather short shaft. Thus, I can not say if these capsules are *p*-mastigophors or amastigophors. The weak sphincter, the division of the column seemingly into a scapus and capitulum make it likely that the species is an Aiptasiid but in such a case it can not be referred to any genus previously known. Verrill who gives only a figure of it, 1899 (p. 146) calls it *Sagartia* (*Psammactis*) *modesta* but without any diagnosis of the new genus. On the other hand, if the capsules are amastigophors, which is hardly acceptable, the species may go to *Actinothoë*.

Adamsia sociabilis Verrill

Adamsia sociabilis Verrill, 1882, p. 225, 314, 315; 1883, p. 45, pl. 8, figs. 2, 3; 1885, p. 534, pl. 8, fig. 26.

Several specimens of this species are examined. Unfortunately they usually are very contracted, the interior is badly preserved and the filaments and reproductive organs are loose from the mesenteries. Owing to that, it was impossible to find any acontia. The sphincter is mesogloeal and well developed (Fig. 7*a*); the retractors of the stronger mesenteries consist of a few but rather high folds (Fig. 7*b*). The nematocysts of the column are 19.7–25.4 by (3.5) 4.2μ (basitrichs); those of the tentacles 9.2–15.5 by 2.5–2.8μ (basi-

trichs); those of the actinopharynx partly 19.7–25.4 by about 3μ (basitrichs); partly about 14 by 4μ, rare (microbasic *p*-mastigophors); those of the filaments partly 11.3–14.8 by 2.2–2.5μ (basitrichs), partly 11.3–13.4 by 3.5–4.2μ (microbasic *p*-mastigophors). Possibly the species is an *Adamsia*.

Bunodosoma grandis (Verrill)

Cladactis grandis Verrill, 1869, p. 472.
Phymactis grandis (Verrill) Stephenson, 1922, p. 285.
Eucladactis grandis (Verrill) Verrill, 1899a, p. 49.

I have examined several individuals from the Pearl Islands. The specimens are of very different size from 0.3 by 0.4 cm up to 3 by 4 cm. The projections of the column are rather thinly set in the smallest specimens, but in individuals of a height and breadth of 1 cm they stay extraordinarily close. Although all their ectoderm is fallen away, so that I can not give any information of its nematocysts, there is no doubt that we have to do with vesicles as they are not adhesive. They are narrow and rather long and show the appearance given by Verrill (1899, fig. 14, a–c). The fosse is well developed, the sphincter rather weak, circumscribed. I have in figures 8*a*, *b*, drawn the sphincter of two smaller individuals (1.5 broad and 0.8–1 cm high). As the ectoderm of the vesicles also at the margin is lost it was impossible to decide whether marginals are present, but in the fosse of two examined specimens the ectoderm is partly preserved. Here I have found numerous nematocysts undoubtedly atrichs. Thus the species is a *Bunodosoma*. The retractors are broad, bandlike, forming high folds. The parietobasilar muscles are situated on a shelf. The nematocysts of the marginal spherules are 35.2–45.1 by 4.2–5μ (atrichs); those of the tentacles 22.6–25.4 by 3μ (basitrichs); those of the actinopharynx 26.1–29.6 by 3.5–4μ, very numerous (basitrichs); those of the filaments partly 21.1–25.4 by 4.2–4.5μ (microbasic *p*-mastigophors), partly 13.4–17 by about 2.8μ (basitrichs).

The species is neither identical with a specimen from the Gulf of California nor with any other species of *Bunodosoma*, which all have larger vesicles. The number of tentacles in *grandis* is considerably greater than in other species of the genus.

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PROCEEDINGS OF THE ACADEMY

432D MEETING OF BOARD OF MANAGERS

The 432d meeting of the Board of Managers, held in the Cosmos Club, November 14, 1949, was called to order at 8:15 p.m. by the President, F. H. H. ROBERTS, Jr. Others present were: H. S. RAPPLEYE, N. R. SMITH, ALAN STONE, W. W. DIEHL, F. M. DEFANDORF, W. N. FENTON, W. F. FOSHAG, F. A. WEISS, W. A. DAYTON, MARGARET PITTMAN, H. W. HEMPLE, O. B. FRENCH, F. M. SETZLER, and, by invitation, H. E. MCCOMB, J. L. SHERESHEFSKY, and F. C. KRACEK.

The President announced the appointment of the following to the Committee for the Academy Journal: L. V. JUDSON (chairman), W. N. FENTON, F. C. KRACEK, PAUL H. OEHSER, J. A. STEVENSON, ALAN STONE, and H. S. RAPPLEYE (ex-officio).

The Committee on Membership submitted the names of six individuals for resident membership in the Academy and five for nonresident.

The Chairman of the Committee on Grants-in Aid for Research, Dr. SHERESHEFSKY, reported as follows:

Members of the Committee on Grants-in-Aid have unanimously recommended that $'50 be granted to EDWARD C. RANEY, associate professor of zoology and fishery biology of Cornell University, to assist him in a study of the distribution of the fishes of Virginia. Of this sum it is estimated that $90 will be used in drafting, engraving, and printing of a stream map of Virginia and the remainder for services in plotting the distribution of over 150 species of fishes found in the State.

The Committee also recommends a grant of $250 to Dr. ANGUS M. GRIFFIN and Miss JEANNE C. MOAN, both of the department of bacteriology, School of Medicine, George Washington University, to assist them in obtaining the necessary materials for the completion of a study of induced variations in the group of coliform organisms. The applicants state that this grant will enable them to repeat some preliminary observations on the intestine type *Escherichia coli* and the *Aerobacter aerogenes*, and also to complete this study.

The Chairman called attention to the fact that the Academy had at its disposal $596.50. In subtracting the recommended grants from this amount, there will remain a balance of $196.50.

The Board unanimously accepted the recommendations made by the Committee.

The Nominating Committee, consisting of the Vice-Presidents of the Academy, reported that it had met at the Cosmos Club on October 17, 1949, FRANCIS E. JOHNSTON, presiding. Others present were: W. N. FENTON, F. D. ROSSINI, J. B. REESIDE, Jr., F. A. WEISS, C. A. BETTS, F. B. SILSBEE, R. S. DILL, A. O. FOSTER, H. W. HEMPLE, H. G. DORSEY, O. B. FRENCH. F. M. SETZLER acted as Secretary but took no part in the balloting. The nominees selected for the offices to be filled by balloting of the membership in December were as follows:

For President-Elect ..... NATHAN R. SMITH
For Secretary ..... FRANK M. SETZLER
For Treasurer ..... HOWARD S. RAPPLEYE
For Board of Managers to serve January 1950 to January 1953 (two to be elected)—HOWARD P. BARSS, CLIFFORD A. BETTS, HAROLD E. MCCOMB, A. T. MCPHERSON.

The Secretary reported the following deaths: SIGURD ORLA-JENSEN, Royal Technical College, Copenhagen, Denmark, on June 24, 1949 (honorary, elected November 8, 1924); GEORGE TULLY VAUGHAN, Washington, D. C., on April 26, 1948 (elected January 17, 1901; on retired list February 15, 1943); WILLIAM J. HUMPHREYS, formerly of the Weather Bureau, on November 11, 1949 (elected May 17, 1906; on retired list December 31, 1935).

The President reported that, as recommended in the report of the Committee on Policy and Planning presented to the Board on September 19, 1949, he had met with the Committee on Membership to discuss various problems in connection with increasing membership in the Academy. He indicated the desirability of appointing subcommittees on membership in various Govern-

ment agencies. It was pointed out that the Committee on Membership should serve primarily in the capacity of passing on the qualifications of the applications submitted to them rather than soliciting new members. The present Committee on Membership would favor such subcommittees. The question of preparing specific qualifications for membership was discussed at some length. However, the Board did not deem it advisable to establish such specific qualifications. A motion was approved extending a vote of confidence to the present Committee on Membership and extending to them a vote of thanks. The Board also approved a motion authorizing the President to appoint several subcommittees, consisting of Academy members in the various Government agencies, who were to prepare nominations of qualified scientists and to forward such applications to the Committee on Membership.

The meeting adjourned at 9:25 P.M.

F. M. SETZLER, *Secretary*

Obituary

SAMUEL FREDERICK HILDEBRAND, senior ichthyologist in the Fish and Wildlife Service, died suddenly in Washington on March 16, 1949, of a heart attack, in his sixty-sixth year. He was born on a farm near Stendal, Pike County, Ind., on August 15, 1883. Surviving are his widow, Claudia Chaillaux Hildebrand, whom he married in 1911, two daughters and a son, and three grandchildren.

Hildebrand was the youngest of 12 children. His parents, Herman Henry and Sophia Weitkamp Hildebrand, though originally endowed with but few worldly possessions, were industrious, thrifty farming folk of excellent stock, who emigrated with their two first-born to Indiana from Münster, Germany, in the closing days of the Civil War. One still had to clear most of the land to be able to farm it, and, driven by stern necessity in those early days, the Hildebrands, both old and young, all contributed their bit to the family's welfare. Samuel had his share of chores about the house and in the fields. Before he was old enough to go to school he was counting out three grains to the hill at corn-planting time, and "worming" the 2-acre tobacco patch. Even his first attendance at school at the age of six was delayed two days because of beans that had to be picked. Most of his early schooling was received from a succession of teachers in the proverbial little red one-room schoolhouse.

Before he "graduated" at 17 he had assisted his teacher with classes on a number of occasions and acquired such an interest in learning and scholarship that he attended a summer normal course to qualify for a teacher's license. Without a formal high-school education, for two years he taught, with marked success, higher grade schools not far from his home. On off days he continued farming to add to his earnings as a teacher, in order to finance a start at the State Normal School, later Teachers College, in Terre Haute. The other funds needed were earned by doing odd jobs, waiting tables, promoting a students' boarding club, tutoring in German, and serving as "chief bottle washer" in the biology lab.

His habit of making every minute count, the result of home training and of farming when not attending school, and his ability to do so well the many necessary things a biology lab assistant was called upon to do, brought him to the favorable attention of Seth E. Meek, ichthyologist at the Field Museum in Chicago. His acceptance of an assistantship proffered by Meek in the spring of 1908, a year before he was due to graduate from Normal, marked the beginning of Hildebrand's serious interest in the study of fishes that was to lead to his becoming one of the world's leading ichthyologists. In the course of his two years with the Chicago Museum he assisted Meek as junior author in the preparation of *A synoptic list of fishes known to occur within fifty miles of Chicago*. This was the first published paper in which he had a hand.

He also found time to take certain courses at the University of Chicago, and, with the credits so obtained, he returned early in 1910 to State Normal to complete the requirements for a B.A. degree. This proved a providential move, for during graduation week he made the acquaintance of a fellow Hoosier, Barton Warren Evermann, then chief of the division of scientific inquiry in the Bureau of Fisheries. Hildebrand soon qualified as scientific assistant for a vacancy of which Evermann apprised him, and on October 1, 1910, he entered the service of the Bureau in Washington, D. C. Within the first three months

he completed his second published paper, with Evermann as senior author, *On a collection of fishes from the lower Potomac, the entrance of Chesapeake Bay, and from streams flowing into those waters.*

By mid-December he was on his way to Panama with Meek as a participant in the biological survey of the Canal Zone, sponsored by the Smithsonian Institution for the purpose of ascertaining faunal and floral conditions in the area before the construction of the inter-ocean canal seriously began. The ichthyological collections amassed by the two of them during five months of field work were to provide Hildebrand with his major interest for the rest of his life and the material upon which some of his finest published work was based: *The fishes of the fresh waters of Panama* (1916) and *The marine fishes of Panama* (3 vols., 1923, 1925, 1938). Though carrying Meek's name as senior author, these monographic treatises were written wholly by Hildebrand and were almost entirely based on his personal study of the collections carried on in winters spent in Washington when not discharging important responsibilities elsewhere for the Bureau. Meek returned from the second trip to Panama a seriously ill man, and died in 1914 without taking any active part in the preparation of the reports other than the brief preliminary descriptions of several new species of Panamanian fish, of which Hildebrand was also junior author.

During the four years (1914–18) that Hildebrand first served as director of the Fisheries Biological Station at Beaufort, N. C., he initiated an invaluable series of studies of the life histories of fishes from egg to definitive young. One of the earliest published dealt with the top minnow (*Gambusia*), just then coming into notice as a natural enemy of mosquito larvae. Thus, when the Navy took over the Beaufort Station in 1918 following this country's entrance into World War I, it was quite the logical thing for Hildebrand to undertake a practical demonstration of the value of the top minnows in malarial mosquito control, under the auspices of the U. S. Public Health Service in the extra-cantonment zone at Camp Hancock, Augusta, Ga. Though this experiment was brought to a close with the end of the war, the results exceeded all expectations. Therefore, the investigation of which that demonstration was a part was resumed as soon as the Public Health Service could again obtain Hildebrand's services. This was early in 1920, after he had completed a 15-month assignment as director of the newly authorized Fisheries Biological Station at Key West. The application of Hildebrand's talents as investigator and consultant to the problem proved so successful that some of the series of significant Public Health bulletins and other papers that he wrote on top minnows, their habits, distribution, and propagation, and their relation to mosquito control were translated into several foreign languages.

Shortly after his return to the Bureau late in 1924 he conducted a 3-month survey of the streams and lakes of the Republic of El Salvador, with a view to the development of local fisheries, their conservation, and the possibilities of the artificial culture of native and introduced species. Although the systematic account of the fishes collected appeared the next year, the publication of the essential results of the survey in Spanish was delayed by the Salvadoran Government until 1936.

The six years following Hildebrand's return in 1925 to Beaufort as director were exceedingly busy ones. It was a period of substantial improvement and expansion of plant and personnel. Such time as could be spared from administrative duties was given over to the continuation of his interrupted life histories of fishes. The life histories of some 44 species were largely completed and published upon in the course of his successive residences at Beaufort. A large series of experiments in diamondback-terrapin culture carried out during the second tour of duty at Beaufort satisfactorily demonstrated that terrapins could be grown in captivity as readily as chickens. His interest in their culture led also to several publications on their biology and that of marine turtles as well.

The first spring after he returned to the directorship at Beaufort, the University of Georgia asked Hildebrand to deliver a 2-week series of lectures on mosquito and malaria control to the Public Health Department of the Medical School. The enthusiastic reception accorded these lectures induced the university to confer the degree doctor of public health on him in recognition of his notable achievements and publications in the field of public health.

In 1931 he returned permanently to Washington, where by choice and with the permission of his Bureau he devoted himself almost wholly to systematic ichthyology except for four brief field trips. The first of these, made in 1933, involved

nearly three months of travel throughout Mississippi as adviser on fisheries matters to the then newly established State Fish and Game Commission. In 1934 a 2-month investigation of the mountain streams of Puerto Rico was undertaken for the purpose of determining their suitability for supporting trout. At that time he recommended bullhead catfish and bluegill sunfish for the lower reaches of those streams and certain impounded waters. These fish later were successfully introduced. Although the trout themselves would thrive in the streams at higher elevations, the water was subsequently found a little too warm for natural propagation. *An annotated list of the fishes of the fresh waters of Puerto Rico* reported on the collections made during that survey.

In 1935 and again in 1937, Dr. Herbert C. Clark, director of the Gorgas Memorial Laboratory in Panama, invited Hildebrand to revisit the Canal Zone at the time of the dewatering of the locks for cleaning and overhauling. The Gatun or Atlantic side locks were the object of his visit in 1935, and the Pedro Miguel and Miraflores locks at the Pacific end of the canal in 1937. The results of his examination of the locks and the animal life found in them were incorporated in his report on *The Panama Canal as a passage for fishes with lists and remarks on the fishes and invertebrates observed.* On both occasions, besides the material taken from the locks, fish were also extensively collected in all available fresh waters throughout the Isthmus. So much new information was secured that Dr. Hildebrand prepared and published *A new catalogue of the fresh-water fishes of Panama*, which included substantial additions to his and Meek's earlier account. At the time of his death he was actively working on the large series of marine fishes also secured on both of these trips to Panama with a view to a similar critical supplement to *The marine fishes of Panama.*

Desirous of giving over his entire time to ichthyological researches, Hildebrand never sought, and indeed refused, all advancement in government service along administrative lines, for which he was particularly well equipped. In his last 18 years in Washington (1931–49) he published more than half of his purely systematic papers, besides completing a number of reports on biological studies made during the Beaufort years on terrapins and the life histories of fishes. Especially noteworthy among the results of his systematic studies, other than those already referred to, were: *The fishes of Chesapeake Bay*, with William C. Schroeder; *Systematic catalogue of the fishes of Tortugas, Florida, with observations on color, habits, and local distribution*, a careful revision of an unfinished manuscript by the senior author, the late William H. Longley; *An annotated list of salt and brackish water fishes with a new name for a menhaden, found in North Carolina since the publication of 'The fishes of North Carolina' by Hugh M. Smith in 1907; A review of the American anchovies (family Engraulidae)*, regarded by Dr. Hildebrand as his most thorough piece of research in systematic ichthyology; and *A descriptive catalog of the shore fishes of Peru.* As the last-named was being concluded and the supplement to *The marine fishes of Panama* was approaching completion, preliminary work was being undertaken on a companion volume on the fishes of Chile, which would have completed the coverage of the ichthyological shore fauna of the entire west coast of the South American Continent.

In point of number of titles, his bibliography is a modest one, comprising to date 75 titles, exclusive of a number of translations of some of them into foreign languages. It embraces several important fields of scientific interest, to each of which significant original contributions were made. Among these fields the papers are distributed approximately as follows: Systematic ichthyology, 33; life histories of fishes, their biology, food habits, and distribution, 12; biology of terrapins and marine turtles, and their culture, 8; mosquito and malaria control, primarily by means of the top minnow, 10; popular accounts and standard reference-work information concerning fishes, the control and conservation of fisheries in specific areas, official reports on biological station operations, and miscellaneous notes, 12. In addition to the foregoing, there are two manuscripts, one complete on *The herrings and herringlike fishes*, written for inclusion in the *Fishes of the Western North Atlantic*, being sponsored and issued by the Sears Foundation, Yale University; and the other the largely completed supplement to *The marine fishes of Panama.*

Dr. Hildebrand was elected to membership in the Washington Academy of Sciences on December 1, 1939; was a fellow of the American Association for the Advancement of Science; a member of the American Fisheries Society, the American Society of Ichthyologists and Herpetolo-

gists, the National Malaria Society, the Biological Society of Washington, and Sigma Xi; and an honorary member of the Panama Canal Natural History Society and the Pacific Sailfish Club. He was frequently consulted by the U. S. Food and Drug Administration and the U. S. Tariff Commission in matters concerning packaged and imported sea foods and fishery products; and he served as a member of the editorial board of the Sears Foundation. At the request of the Navy Department, he furnished most of the names of fishes used to designate submarines during World War II. He was a member of the board of trustees of the Brookland Methodist Church in Washington and for some years secretary-treasurer of the Brookland Citizens' Association.

Though raised in a strictly fundamentalist atmosphere in which the Bible was literally interpreted, Hildebrand was broadminded in his religious beliefs. He believed that what really counted after all was the service rendered one's fellow men, even in the work we do. At one time he entertained the idea of entering the Methodist ministry, as had one of his brothers. On more than one occasion he delivered memorable lay sermons for his church. Sunday school he taught as a young man, and again in his more mature years at Beaufort and in Brookland. In the latter place he conducted a class of young adults. He was an inspiring, much revered and sought-after teacher. It was at a Wednesday evening meeting of this very class that he was fatally stricken.

Altogether too rarely does the world produce men of such substantial achievement, sterling worth, and high character, so truly Christian in every sense of the word, respected and beloved not only by his Sunday-school classes and the fellow members of his church, but by all who ever knew him as a man and scientist.

WALDO L. SCHMITT.[1]

[1] Although Dr. Hildebrand was an intimate and dear friend of mine since our first meeting in 1910, when we were both appointed to the staff of the old Bureau of Fisheries, these notes are in large part based on an autobiographical sketch that he prepared in 1944. I am indebted to Mrs. Hildebrand for her kind permission to make use of that material as I desired.—W.L.S.